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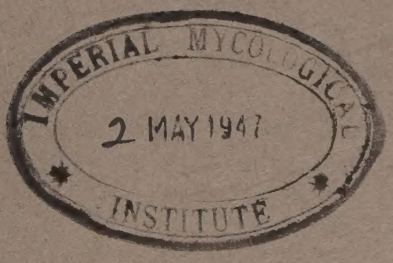

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Vol. 12, No. 4 DECEMBER, 1946

Land Utilization Surveys*

By
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Department of Geography, University of Sydney.

The Development of Land Utilization Surveys.

Field survey for land utilization survey mapping is still in its beginnings. With the exception of the land utilization survey of Great Britain and some surveys in U.S.A., land utilization surveys in most countries are not even projected. It will be sufficient to refer only to certain " key " papers from Britain and U.S.A. to indicate how land utilization surveys have developed to date. With these in mind the present position of land utilization surveys in Australia can be examined.

Land Utilization Survey of Britain.

Proposals have been made from time to time for a geographical description of the British Isles since that first made by Mill in 1896.[7] A number of papers have appeared which include a description and often a map showing various forms of surface utilization, but the term land utilization does not seem to have been used. With the development of regional surveys this form of survey received increasing attention. Thus Fagg and Hutchins,[1] devote a section of their book to a " surface utilization survey ". The various categories indicated here, 32 in number, form a very complete classification of the various forms of surface utilization in Great Britain. Dr. L. Dudley Stamp, after the pioneer example of the land utilization survey of north Hamptonshire,[13] conceived the idea of carrying out a land utilization survey of Britain.[14] The primary object of the survey was to make a record of the existing use of every acre of land in England, Wales and Scotland. The scheme of land classification adopted by the land utilization survey of Britain is based essentially on existing land use.

The survey was carried out on the six-inch ordnance survey maps. The results were reduced to a scale of one inch to the mile, and it is planned to publish through the Ordnance Survey a series of sheets corresponding exactly to the popular series of one-inch ordnance maps, but showing land utilization.

The classification is divided into six main categories :

(1) Forest and woodland :
  (*a*) High forest, suitable for the supply of timber.
  (*b*) Coppice or coppice with standards, suitable for the supply of poles, fencing standards, brushwood, etc.

* The substance of this and that of the two succeeding articles by Mr. C. G. Stephens and Miss Sheila Rowley respectively, provided the basis for a discussion at a joint meeting of Sections K and P of the Australian and New Zealand Association for the Advancement of Science held in Adelaide on 27th August, 1946.

(*c*) Scrub or woodland of small trees and bushes unfit for cutting.
(*d*) Deforested areas or woodland cut over and not replanted.
(2) Meadow and permanent grass.
(3) Arable or tilled land.
(4) Heathland, moorland, commons and rough hill pasture.
(5) Gardens, allotments, orchards and nurseries.
(6) Land agriculturally unproductive.

It was claimed that this survey provides
(*a*) a standard of comparison with the past, and
(*b*) a basis of planning for the future.

It was pointed out with respect to the latter use of the survey that there had been considerable discussion regarding the reorganization of British farming, yet a land utilization map showing the existing organization of British agriculture was lacking. Dr. Stamp pointed out that " if the time does come for extensive reorganization in definite areas, surely it will be the topographic, the geological, the rainfall or climatology and land utilization maps when considered together that will make possible a definite scheme on a sound scientific foundation ". A further aim of the land utilization survey was to interest the nation in the land and its uses, and thus to secure the support of a well-informed public opinion for the work of planning the land for the future and for the benefit of all.

Land Utilization Survey in United States.

The growth of present day land utilization surveys in United States seems to have had its origin in the proposed establishment of a soil survey for the State of Michigan. C. O. Sauer, writing in 1917,[9] urged that some of the lines of inquiry should be extended so that the soil survey would evolve into an agricultural survey. He set out a detailed proposal for the broadening of the scope of the survey to be organized on a geographic basis. In 1919 Sauer published a paper[10] in which he presented a plan for the economic mapping of a small area on a large scale and included a map showing the utilization of the land as an example.

Sauer proposed the following groups :

(1) *Barrens.* Areas too destitute of vegetation to serve for grazing or cutting timber, recent sand dunes, beaches, areas of bare rock.

(2) *Woodlands*, woodlots, cut over lands, commercial timber land.

(3) *Permanent pastures and meadows.* (*a*) Meadows for hay and pasture ; (*b*) wood and stump pastures, partially cleared forest land in transition from forest to grass ; (*c*) wild pastures ; (*d*) seeded pastures (the latter often represents a temporary use of cultivated land).

(4) *Cultivated land.* (*a*) Agricultural, in this group the crops of individual fields change at frequent intervals. It was suggested that the crops be distinguished on the basis of a crop series including all important crops commonly grown on the area in question ; (*b*) horticultural. In horticultural lands the subdivisions are simple, because the products of individual areas ordinarily remain the same for a number of years. Subdivisions might be as follows : (1) orchards, (2) vineyards, (3) market gardens.

(5) *Town sites.* In town lands the varying types of land use such as residential, industrial, commercial, retail, warehouses, transport facilities, etc., would be mapped.

Sauer's advocacy for the extension of the survey seems to have borne fruit, for when it was established in 1922 it was entitled the Michigan Land and Economic Survey. Schoemann,[11] in describing the methods followed in this survey, states that " Michigan's problems of conservation . . . have forced on those interested in the State's growth and development a realization of the keen necessity for formulating an intelligent and constructive policy to guide the use, development and conservation of the idle lands, the forests and other natural resources . . . What is required are policies based on facts obtained from two localized sources of information . . . First an inventory by counties or regional units of the present status of the State's resources and the industries arising out of and dependent upon their development and use ; and second a study of the economic conditions and factors which are accountable for the present existing use or lack of use." For nine years the work of the Michigan

Land Economic Survey continued as a division of the State Department of Conservation, making a land inventory as a basis for planning land utilization. It was only in 1931 that the policy of the survey changed from " inventory only " to one of land-use planning. This change of policy is discussed by Schoemann[12] in a paper in which he presented details of making a plan and illustrating it by data from selected counties.

Another example of the development of land utilization surveys in U.S.A. is contained in a paper entitled " Land Utilization in the Service Area of Montford, Wisconsin ".[2] The paper is illustrated by a map (scale 2·7 inches = 1 mile (approx.)) showing utilization of land in its relation to conditions of slope, soil, drainage and roads.

The paper advocated and used the fractional notation method for collecting and correlating the data.

Mapping of the major types of land use involved the recognition of 11 primary classes of land-use. These were :

1. Tilled land.
2. Permanent grass land.
3. Timber land.
4. Idle land.
5. Transportational land.
6. Farm steads.
7. Urban residential land.
8. Commercial land.
9. Manufactural land.
10. Mineral land.
11. Land occupied by public buildings or in similar public use.

Further subdivision of groups 1 to 4 was given.

The Soil Conservation Service of U.S.A.[8] at present maps the present land-use in conjunction with degree of soil erosion and lay of the land. The purpose of the mapping of land utilization is to help in the classification of the land according to use capability.

In these surveys four major land use classes and a miscellaneous class are recognized. Divisions of the major classes may be mapped if established and approved as part of the survey plan.

The following land-use classes are recognized :

L. Cropland. Cropland includes all land planted to crops, fallow land, orchards, and land seeded down several years to grass, alfalfa, or other forage crops grown in rotation for hay.

X. Idle Land. Land either void of vegetation or maintaining plant growth of little economic or agricultural value is mapped as idle land.

P. Pasture or Range. Pasture includes grazing land or range other than pastured woodland, and land in grasses or legumes that is devoted primarily to grazing.

F. Woodland. Woodland includes land with 40 per cent. of the ground covered by the spread of woodland or forest species of any age and land devoted to forest plantations. Pastured woodlands and virgin woodlands are divisions of this class.

H. Miscellaneous. Urban areas, large farmyards, golf courses, and areas not otherwise classified are included in class H.

Land Utilization Surveys in Australia.

With the development of town and regional planning and a reawakening in the problems of land settlement, there is an ever-increasing demand for more information about the use to which the land is being put at the present time and the most appropriate future use of the land.

In Australia a variety of studies of land-use are now appearing. All these studies differ both in approach and in detail. There is no consistent or uniform outlook and no set principles in land utilization mapping have been followed. This would appear to be due to the fact that land utilization surveys have been developed by various specialists as side lines to their main work. Thus we see economists, soil surveyors

and geographers, all producing surveys which they call land-use surveys, and which are all very different.

One of the earliest papers on land utilization in Australia was written by J. Macdonald Holmes, in which he discusses " Land Utilization, Problem in Economic and Political Geography ".[3] Holmes attempts a definition of the meaning of land utilization and discusses the significance of the terms land occupation, land classification and land utilization. This was followed by an article by the author on land utilization in the Lower Hunter Valley, N.S.W.[5] This is a detailed study of land utilization in an area of 1,000 sq. miles in the Hunter Valley and seven major categories of land utilization are recognized and mapped on a scale of 1 inch to 1 mile.

Probably the best known statement on land utilization in Australia is Wadham and Wood's book.[20] This is a general study of the factors which have influenced the successive phases of land utilization in Australia ; the factors controlling the use of land ; a description of each of the major land industries and a series of broad conclusions and a brief survey of some economic and international questions bearing upon land utilization. This is easily the best text available on Australia's primary production, but only in the broadest possible sense is it a study of land utilization in Australia.

The following six studies are representative of other land utilization studies which have appeared in Australia.

The Land Utilization Regions of Tasmania[4] is a general study of Tasmania on a small scale. The groupings and boundaries in the map have been generalized to illustrate the extent and pattern of the various types of use. The text is a general one dealing with various types and detailed studies of typical areas in one region are included.

The land-use studies of the County of Grey,[15] Wakool Irrigation District,[17] and part of County Victoria,[16] illustrate land-use surveys published by the Soils Division of the C.S.I.R. in conjunction with their soil surveys. In the County of Grey study, the land-use types are divided into eight categories. The first six indicate increasing intensity of land-use from sparse grazing and with increasing development to intensive pasture with some agriculture. The last two categories refer to forest and forest plantations.

In the Wakool Irrigation District study the land-use is discussed under the heading of various types of activities, i.e. dairying, etc. The land-use study in the survey of part of County Victoria shows an increasing interest in land utilization studies. Seven land-use types are recognized and are differentiated on the basis of crop series or rotations, following somewhat the scheme set out by Sauer in 1919.

These three studies reveal an increasing interest in land utilization and a widening of the scope of the work of the Soils Division. It is obvious that if much more work of this nature is attempted the Soils Division must consider the drawing up of a programme and classification for the uniform collecting of data in land utilization.

The classification proposed for land utilization in the Survey of Soil Erosion in Victoria[19] is based upon type of industry with an additional detailed classification of forested areas.

The land utilization classification illustrated in the new atlas on regional planning by the Tasmanian State Economic Planning Authority[18] shows eight categories and follows somewhat, though in more detail, the pattern laid down in the study of Tasmania by Lowndes and Maze.

Finally, reference may be made to the classification devised for the Tamworth survey.[6] This was planned to provide a framework for a survey of the sheep-wheat belt of N.S.W. It shows seven major categories, the first four arranged to indicate increasing intensity of use. A classification such as this can be used both for general and detailed studies at various scales. In a general survey the major categories only would be used and with increasing scale more and more subdivisions could be identified.

CLASSIFICATION OF OCCUPATION AND DEVELOPMENT OF THE LAND
TAMWORTH REGIONAL SURVEY (1937).

Scale of map : 1 in.=1 mile.

(*a*) *Undeveloped lands.*
- (i) Woodland and forest.
- (ii) Forest reserves.
- (iii) Second growth (like virgin).
- (iv) Waste lands (bare rock, etc.).

(*b*) *Developed for pastoral purposes only.*
- (i) Natural grassland. Naturally free of trees, i.e. the Black Soil Plains.
- (ii) Cleared or partly cleared of trees, good pasture, well grassed, good herbage country, some areas suitable for cultivation.
- (iii) Partly cleared of trees. Poorer pasture, mainly coarse grass, steep country with shallow soils.
- (iv) Swampy pasture.

(*c*) *Developed for agricultural and pastoral purposes.*
- (i) Stubble or fallow land (used for grazing between crops).
- (ii) Grazing lucerne.
- (iii) Cereals.
- (iv) Fodder crops.
- (v) Root crops.
- (vi) Miscellaneous crops.

(*d*) *Developed for cultivation only.*
- (i) Commercial lucerne.
- (ii) Orchard and vineyards.
- (iii) Market garden and tobacco.

(*e*) *Developed for transport purposes.*
- (i) Railway lands and associated trucking yards.
- (ii) Roads and stock routes.
- (iii) Travelling stock reserves.
- (iv) Airports.
- (v) Wheat silos and trucking yards.

(*f*) *Developed or reserved for buildings, urban areas and associated public lands.*

(*g*) *Developed for mining and quarrying.*

The Scope and Object of Land Utilization Surveys.

Since utilization is the keynote, a land utilization survey must first of all make a record of the existing use of every acre of the area and distinguish between use and non-use.

Many terms have been used in the classification of land-use and in spite of their similarity these terms do not all mean the same thing and they are not interchangeable. The main concepts used have been :

Productive and non-productive. The critical element here is	.. Yield.
Improved and unimproved or developed and undeveloped	.. .. Labour.
Type of industry or activity	.. Type of product.

It is obvious that it is most desirable for us to keep in mind and clarify our ideas on the various sets of criteria for classifying land-use. Should major emphasis be given to use, or to production, improvement or type of activity ?

A land-use map should portray the following :

(1) The use to which the entire land surface is put—woodland, pasture, arable, etc.

(2) The purpose or object of the various types of use—dairying, commercial grain production, etc. (type of farming).

It is obvious that two areas may be used in exactly the same way, but for very different purposes. It is therefore necessary to distinguish between type of use and type of activity.

The land-use map and written report should also indicate

(3) The degree of effectiveness of the land-use.

(4) The nature and extent of the wastes and abuses of the land.

Maps of the area as nature made it (climate, slopes, soils, hydrology and vegetation) should accompany the land-use map, it is explained by them, and, in

turn, the land-use map serves to interpret them. They define the extent and nature of land-use in accordance with the stage of development, the more desirable lands having a great variety of possible uses, the less desirable having few possible uses. Each type of land utilization has its own particular limiting conditions. The more extensive types of land-use are those which are adaptable to a wide range of environmental conditions and recognize few limits. As development proceeds, and land-use changes in character, the requirements become more specialized. As a result, the areas suitable are more limited in extent. So a more intensive type of land-use can rarely completely succeed the previous one. It is confined to a smaller proportion of the land, and remnants of the previous one remain in the marginal and unsuitable lands.

Combined, this group of maps gives full details of the area as the home and scene of activity of the inhabitants. The land-use map shows the distribution and pattern of their activities, it suggests interrelations, and directs attention to the future scope and limitations of production.

Such a scheme of mapping sets out the broad principles on which land utilization mapping should be based. Emphasis is placed on utilization, and the manner and degree of utilization should be characterized. These general principles will determine the scope and object of the survey. For any particular locality the local conditions will determine the details of the classification.

It is apparent that land utilization survey necessitates the cooperation and integration of the work of a number of specialists. The nature of the prevailing land use determines the calling of the specialists (forester, agronomist, agriculturist).

Land utilization mapping, while supplying the regional geographer and the land planner with essential information, serves other broader purposes. Land utilization maps in conjunction with soil maps must form the basis for any scientific method of land valuation and taxation.

The Logical Outcome of Land Utilization Surveys— Land Planning and Valuation.

When a land utilization survey is completed a number of things may be apparent immediately, such as

(*a*) possibilities for developing unused areas,
(*b*) possibilities for intensification of use in lightly used areas,
(*c*) necessity for restriction or extension of certain types of land-use.

If sufficient additional information has been collected the economic situation of the area should be fully understood and the prospects of future development could be stated.

The next logical step, therefore, is to set out the possibilities of the area to show the most appropriate future use of the land in the form of a land utilization plan. The classification would set out the best and most complete use of the land in the immediate future. It would propose workable changes in land-use where considered necessary on the basis of development of idle lands, remedied use in areas subject to abuse and intensification of use. A land utilization plan, or land classification or land-use capability as it has been called, can therefore be defined as a qualitative assessment of the land considering the land as a permanent resource under a normally developing economic system. If the term land valuation* is applied in a broad sense, it is land valuation that a land utilization plan attempts.

In a land utilization plan one is largely guided by the use and the performance of the land up to date, emphasis being placed on the land and not on the differences

* Land valuation at present is based essentially on the prices paid for land. Prices do constitute a sort of land classification for they express the expectation of returns from the land. But because prices of land are the result of many factors other than the average expectation from their utilization, land prices alone do not constitute an effective means of land valuation or classification.

in skill of the individual producers. The classification of the land according to quality will be determined by an appraisal of its physical character. This will only partly determine the desirability of land. Into this consideration comes the market value, which is mainly an expression of the stage of development. It is also influenced by the determination of policy for national development.

Need for joint Approach to Land Utilization Surveys in Australia.

Making a land utilization plan for the future is essentially the work of securing the optimum use for the benefit of all. If this is to be done, then planning the land for the future cannot be regarded as an exclusive province of any one group of experts. Successful and lasting land planning must be a cooperative work, carried out for the benefit of all and made possible by the goodwill of all.

Before we can embark upon the formulation of a land utilization plan, a considerable amount of research into the problems involved will be necessary. The proper utilization of the land for agricultural purposes must depend primarily on the potentialities of the soil. The utilization of any given area may vary from time to time within certain limits according to the stage of development, which may be expressed in the economic requirements of the moment or alterations in the facilities for transport. Despite this, the fundamental natural factors must exercise a controlling influence on land utilization. The investigation of the area as nature made it will concern itself with an examination of the climate, soil and vegetation cover, to mention the chief of the natural factors involved. Such natural factors will be in operation a century hence when the economic set-up may be entirely different.

Where a successful land utilization plan has been carried out in other parts of the world, it has started from the existing land utilization and has attempted to mould the development along sound lines; it has sought to disturb as little as possible the existing position. In the two most important examples of land utilization surveys quoted, viz. the Land Utilization Survey of Great Britain and the Michigan Land Economic Survey, they both followed the same policy of making their inventory of land utilization and associated problems a basis for formulating a land utilization plan in the future. In their planning they proceeded to weigh the several possible uses for each land area of individualistic physical character on the balances of economic environment and social need, to determine the particular use or combination of uses which will yield the most satisfying product or function.

The reasons which have been put forward for the necessity of land-use surveys in other countries apply with even greater urgency in Australia today. In Australia there is no state or nationally organized land utilization survey. Instead, we find a number of individuals in institutes and government departments making surveys which they call land utilization surveys as part of their activities associated with other types of surveys. The need at the present time is for a unified scheme for land-use surveys; an approach which will give uniform and comparable results throughout the whole Commonwealth. If the logical outcome of the land utilization survey is the formulation of a land utilization plan for the future, perhaps on a regional basis, then a land utilization survey must be planned with this object in view. Sufficient land use surveys have now been carried out in Australia to enable a group of experts to become familiar with the scope and nature of such surveys. These people should be brought together to draw up plans for a land utilization survey of Australia.

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The Purpose and Technique of Land-Use Surveys in South Australia*

By
C. G. STEPHENS, M.Sc.

Two major land-use surveys,[1, 2] both in conjunction with soil surveys, have been completed in South Australia. The first, in 1940, covered five hundred square miles of County Grey in the lower south-east of the State, and the second, in 1941, embraced six hundred square miles of County Victoria in the middle north.

The County Grey survey covered country used for both agriculture and forestry. The agriculture consists in the grazing of sheep for wool and fat lambs, some grazing of dairy cattle and a little arable farming, while forestry covers the extensive production of plantation softwoods and a limited production of fencing timber and railway sleepers from the native eucalypts. The purpose of the survey was twofold. The first object was to relate actually established land-use techniques to soil types and, with the aid of the soil map, indicate with some accuracy the total productivity potential of the area covered by the survey. The second object was to provide a key to the potential use of the land on the same and related soils in the adjoining Hundreds of Counties Robe and Grey, an area of some four thousand square miles where much the same ecological and climatic conditions prevail. Actually, this soil and land-use survey is providing, at the present time, a key for the planning of post-war settlement of ex-servicemen in the two counties.

Two points concerning the technique of compiling the survey are of particular interest. Firstly, aerial photographs were used in the field, the data collected from them and the simultaneous inspection of each farm or holding being placed as an overlay on the soil map. Incidentally it was found possible from a charact. ristic pattern on the aerial photograph to identify the topdressing of pastures with superphosphate. Secondly, two categories, natural forest and softwood plantations, were used for forest activities ; and six categories, with accessory cultivation in one case, were used for grazing. This subdivision of the grazing rate was absolutely essential because carrying capacity varied from as low as one dry sheep per 10-20 acres on " fired " heathland up to three or six dry sheep per acre on highly improved pasture.

* See footnote to article on " Land Utilization Surveys ", by Wilson H. Maze.

Without this detailed subdivision which in the greater part could only be established and identified by an experienced agriculturist, the survey would have lost most of its usefulness.

The County Victoria survey covered arable valley floors and stony hill land used mainly for the production of wheat and the grazing of sheep for wool and meat but there is some production of plantation hardwood timber and a little horticulture. The purpose of the survey was to relate details of the wheat-growing rotations and the grazing of sheep on native hill pastures, and, in a lesser degree, on lucerne and fallow land, to soil and pasture deterioration and ultimately to the incidence of soil erosion.

Aerial photographs of a scale of 20 chains to the inch were used in the field, data concerning soils, land-use, erosion and hydrology being entered directly on the photographs. The mapping categories of land-use had to be kept to simple units and comprised : land used for wheat growing, land under lucerne, natural pasture, forest areas, and a few very minor categories. The data concerning the details of the wheat-growing rotations and rates of grazing of sheep were sought by interviewing all the farmers in the Hundred of Belalie. This data was then related to soil structure conditions and the degree of erosion on the farms by selecting sites for soil structure studies where different rotations and forms of land-use had been used. It was concluded that the principal direct causes of the increasing severity of erosion in the area were the narrow two-year fallow-wheat rotation commonly practised and the general overgrazing of the hill pastures.

The two surveys described above have been outlined in some detail so as to emphasize the point that if land use mapping is to interest the agriculturist as well as the geographer, then any general system of mapping satisfactory to and desired by the latter must be elastic enough or capable of sufficient subdivision of its categories to give the former an opportunity to derive detailed internal agricultural relationships. In the main the geographer is interested in comparing one region with another, whereas the principal interest of the agriculturist is in the effect of the different degrees and forms of land-use on the area itself and on the welfare of the residents.

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An Economist's Approach to Some Problems of Land-Use*

By
Sheila Rowley.

The two preceding papers have outlined several aspects of land use work. This paper will describe the part an economist can play in a team engaged in field surveys of farming. Briefly his part is to measure and interpret farm production functions. Every region presents a different combination of what the economist calls the " factors of production ". Much can be learned regarding the proportions in which these factors are combined by comparing the results of surveys conducted in widely differing natural environments. Some of the results from four different farm surveys are set out in quantitative terms in Table 1. A brief historical account of each area precedes the discussion of the table.

Table 1.
Comparison of Results from Four Farm Surveys.

Regions.	Avon Valley, W.A.	Berriquin I.A., N.S.W.	Margaret River-Nannup, W.A.	Murrumbidgee I.A., N.S.W. (horticultural farms only).
Total area of region, square miles	2,016	945	2,055	53
Farm holdings—				
Number in region	752	732	400	1,043
Number cooperating in economic survey	85	11	120	10
Effective size of holding—mode.	1,000 cleared arable acres.	Sown pasture and/or arable acres (mode not known).	100 acres of sown pasture.	20 full-bearing acres.
Land classes—				
Number	5 (*a*)	10 (*b*)	1–5 (*c*)	5 (*d*)
Basis of mapping	Not mapped.	Soil associations.	Soil type and productivity.	Land-use recommendations.
Scale of map	—	160 chains = 1 inch.	20 chains = 1 inch.	20 chains = 1 inch.
Labour units per holding—				
Range	1–12	1–12	1–5	1–12
Average	2	2	2	2
Improved capital value of holding per acre, average	About £5 per cleared arable acre.	About £7 per cleared arable acre.	£13 per acre sown pasture.	£180 per full-bearing acre.
Productive efficiency	Difference between farm income and farm outlay per cleared arable acre (value not known).	Difference between farm income and farm outlay per cleared arable acre and per acre-foot of water (value not known).	£6/10/– less £3/10/– = £3 per acre sown pasture, or 40 lb. butterfat plus sidelines per acre sown pasture.	£81 less £46 = £35 per full-bearing acre, or 4 tons fruit per full-bearing acre.
Types of farm enterprise (ranked by value of products sold).	Wool, wheat grain, fattening lambs and sheep, pigs, barley grain, oaten hay, vines, citrus, honey.	Wheat, breeding and fattening lambs, wool, fattening store sheep, lucerne and oaten hay, dairying.	Butterfat, pigs, cull cattle, potatoes, poultry, apples.	Citrus, vines, peaches, apples, pears, prunes, plums, apricots, vegetables.

(*a*) Classified by Mr. C. G. Stephens, Division of Soils, C.S.I.R.
(*b*) Based on C.S.I.R. Soil Survey of soil associations.
(*c*) Based on C.S.I.R. soil survey of soil types.
(*d*) Based on C.S.I.R. soil survey and local knowledge of productivity.

Description of Areas Examined.

The Avon Valley.

The Avon Valley was one of the earliest farming settlements in Western Australia. Parts of it have been cultivated for over 100 years. The early homesteads were close

* See footnote to article on " Land Utilization Surveys ", by Wilson H. Maze.

to the river. The alluvial flats were tilled for grain and hay, while sheep and cattle were shepherded in the surrounding unfenced savannah woodland. Originally the land was held in large estates of tens of thousands of acres. Most of the old holdings have been voluntarily subdivided, so that there are only 16 estates of over 2,000 acres left today. A feature of this area is the irregular shape of present farms. Broken holdings, the components of which are several miles apart, are fairly common. There is practically no potentially arable land left uncleared on any holding; nor is there much Crown land available, except on the outer fringe of sclerophyll forest to the west of the area. As it is rather difficult for farmers to change the size of their holdings, systems of farm management have to be fitted into the present somewhat haphazard pattern of land ownership.

The Berriquin Irrigation Area.

The Berriquin Irrigation Area, between Berrigan and Deniliquin in New South Wales, provides a water right of one acre-foot for every ten acres of farm holding. The intention was to stabilize the arable-livestock farming of the area, which was susceptible to droughts. So far there has been no restriction on the use of water, and during the six years since the initiation of the scheme settlers who were in a position to do so have used from three to about seven times their water right. The channel design allows for a distribution not exceeding three times the water right to each settler, assuming the water is distributed evenly throughout the irrigating season. Clearly once further developments have been made by those whose water requirements have been low, the time must come when definite restrictions will be imposed. The problem of the area is that the two main enterprises—wheat-growing and the raising of fat lambs—require peak deliveries of water in the early spring and early autumn, and unless there is further diversification of farming it is obvious that the present channel system will not deliver three times the water right.†

The Margaret River-Nannup Area.

The Margaret River-Nannup area of Western Australia could hardly claim to be a dairy district before the government-sponsored scheme of immigration and land settlement, known as "group settlement", was launched in the early twenties. Prior to that time the land, which carried dense forest, had been used primarily for timber felling. Further east at Nannup on the banks of the Blackwood River there were some old homesteads, and areas of the rather lighter forest had been cleared and used for grazing cattle. The management was of the migratory type, in that cattle were driven down to the coast and left there for several months of every year (from December to May) and grazed on large unfenced coastal leases. The idea underlying the new settlement—of making a living solely from 80 acres of sown pasture—was a complete innovation to the area. The land was surveyed into blocks of about 160 acres of suitable country. The Government appointed a foreman to each group of 15 to 20 blocks. The intending settlers camped in tents and worked together in gangs until 25 acres were totally cleared on each block. Meanwhile wooden homes had been erected on the blocks by contractors. By the late twenties there were some 25 "groups" established in the area. After a settler took possession he proceeded alone with the clearing of the rest of his block. Today there is an average of 100 acres of sown pasture per holding, so that in the intervening 15 years settlers have managed to clear or part-clear about five acres per year $(5\times15)+25=100$. The tendency has been to aggregate rather than subdivide. Orderly aggregation has been facilitated by abandonments, so that the pattern of land ownership today is fairly regular. Divided holdings are uncommon. On the average a third of every holding remains uncleared. The main problem confronting every settler is how to get the balance of his land economically into production.

† Mr. F. Matthews of Corowa very kindly supplied some of the information regarding this area; some of the figures in the table have been taken from Smith, C.S.I.R. (Aust.) Bull. 189, 1945.

The Murrumbidgee Irrigation Area.

The Murrumbidgee Irrigation Area of New South Wales was formerly the site of four or five station homesteads, the land then being used for extensive grazing of natural pastures. The land began to be settled for irrigated horticultural farming just prior to the first world war. Development then lapsed until after that war. The bulk of the area was made available to soldier settlers. The pattern of land ownership is fairly regular, although aggregation has occurred here too. There are two distinct classes of holdings in the area. The horticultural farms range from about 20 to 50 acres in size. The " large area " farms, producing livestock, wheat and rice, range from about 200 to 700 acres.

Measuring Factors of Production.

Turning now to consider Table 1, it may be remarked that the most suitable unit for measuring " effective size " of farms may be fairly readily determined in the field ; that is to say, it is not difficult to determine whether to use " full-bearing acres " or " acres of sown pasture " or some other measure. It should be mentioned that the results given for each of these areas were secured by original field work. " Land class " too can be determined only in the field. An economic survey can be much more efficiently conducted if the land classes have been previously mapped. In dealing with " farm enterprise " the most straightforward procedure is to simplify the population at the commencement by selecting an area where the farmers specialize very largely in one line, and so to exclude any non-specialists from the population. This procedure was satisfactory in the Margaret River-Nannup Area, on the other hand in the Berriquin Irrigation Area or the Avon Valley it would not be satisfactory, as the farming there is essentially mixed. A physical measure of productivity serves to compare one specialist region with another ; for example, Margaret River-Nannup produces 40 lb. butterfat per acre of sown pasture, while certain irrigation districts in Victoria produce 80 lb. per acre of sown pasture. However, to compare mixed farming districts with each other or with specialist districts it is necessary to use a monetary measure. The difference between farm income and farm outlay per effective acre is a suitable measure for this purpose. As would be expected, the " improved capital value per effective acre " rises in somewhat the same proportion as does net income per acre.

It seems likely that farm production is a function of certain specific measurable factors. The calculation of appropriate production functions involves the use of statistical analysis. The particular task of the economist in land-use work is to secure thoroughly representative and accurate records, from them to calculate farm production functions and to interpret these functions to other workers in the field of land use. Statistical tests of reliability will demonstrate the degree of faith to be placed in his results. Some of the figures given in the table have still to be confirmed. It should be stressed that they are merely used here for illustration, in the absence of any more complete Australian examples.

What are the questions an economist would ask himself at the outset of a field survey ? How do farm production functions help in answering these questions ? The questions which follow and the answers drawn from four field surveys will illustrate the main types of contribution to land use work which can be expected from economists.

In what proportions are the factors of production—land, labour, capital and enterprise—combined in an area ? Land and labour are combined on the average as follows :

10 full-bearing acres per man on the Murrumbidgee Irrigation Area.
50 acres sown pasture per man at Margaret River-Nannup.
500 cleared arable acres per man in the Avon Valley and Berriquin Irrigation Areas.

While land and capital are combined as follows :

£5 per cleared arable acre in the Avon Valley.
£7 per cleared arable acre in the Berriquin Irrigation Area.
£13 per acre sown pasture at Margaret River-Nannup.
£180 per full-bearing acre on the Murrumbidgee Irrigation Area.

Which factor is limiting ? It is usually land, that is, land of good quality. If this were not so, it would pay farmers to extend the scale of their operations indefinitely, so as to reap the fullest benefit of large-scale operations. In practice they can only expand on to unsuitable land, which will not show the same returns either for annual outlay or for capital outlay on development.

How shall we measure the physical variability of land ? This is mainly a question for soil scientists. But it is one which economists may help to solve. We have given some thought to it at Margaret River-Nannup. At Mr. C. G. Stephens' suggestion we have related the five mapped soil types there to their productivity in terms of butterfat from actual farm records. We are attempting by multiple correlation analysis to demonstrate the influence which soil type exerts on yield, and so to lead on to a rating of the types according to their productivity for butterfat.

What are the relative amounts of other factors which can be most effectively added to the various classes of land ? This involves rating farm operators according to their farming ability, and studying particularly the management practices of the more efficient men. We are attacking this rating problem statistically.

Is it possible to predict farm labour returns from given levels of the various factors of production ? Or putting it another way, what area of land of a given class is required to ensure any given return to labour ? At given prices of products and at given levels for farm wages and other costs, prediction can be reasonably attempted. For example, at Margaret River-Nannup, with butterfat worth 2/- lb. as it was last year, and with other prices at their appropriate levels, the average labour return for twelve months' work was £177 per worker. On the Murrumbidgee Irrigation Area last year the average labour return, calculated in the same way, was approximately £350. There is a linear relationship in each case between farm labour return and the number of effective acres per holding. It can be predicted with a fair degree of accuracy what acreage would be required in an average season to bring the Margaret River-Nannup returns up to the level of the basic wage (£260).

Conclusions.

Now we can summarize the golden rules for farm surveyors, assuming we have complete freedom to work where and how we wish. Firstly, we should choose an area of relatively homogeneous climate, where a soil map on an appropriate scale is available. Secondly, if possible, it should be an area largely of specialist farmers ; alternatively, only the specialist farmers in one enterprise should be included. Thirdly, we should personally visit a large proportion of the farmers in the area. Fourthly, we should collect quantitative data on the main determining variables, in both money and physical terms. Fifthly, the records should be subjected to statistical analysis. The most mature understanding of the complex problems of the use of land can only be expected to result from teamwork, when the techniques of the geographer, agriculturist, economist and statistician are pooled.

By way of conclusion let us pay a tribute to the work of A. J. Perkins, who was at one time the Director of Agriculture in South Australia. Perkins made valuable contributions to the study of agricultural economics in Australia. His costing work at Turretfield is an example of what may be achieved by this most exacting method of approach. Together with his study of Mallee Farm No. 1, it represents an interesting and isolated example of the use in Australia of the detailed case history method. At the 1928 meeting of the A.N.Z.A.A.S. in Hobart Perkins presented a carefully considered plan for further farm survey work. Eighteen years later we can scarcely do better than commend his works to all aspiring agricultural economists.

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Climate and the Distribution of Citrus*

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The majority of the production problems of commercial fruit growing are the result of cultivating varieties under conditions of soil and climate not well suited to their specific requirements. The cultivation of fruit varieties under such conditions when more favourable locations are available seems to be undertaken :

(1) because of some economic advantage, such as proximity to markets or favourable time of harvest in relation to market demands, etc., enjoyed by the area of production ; and
(2) as a consequence of lack of information by the grower as to the specific soil and climatic requirements of the varieties cultivated.

The world distribution of citrus growing areas, especially those of the northern hemisphere, affords a good illustration of distribution determined primarily by economic factors. The principal producing areas in California, Florida, Spain, Italy and Palestine are located in the vicinity of the coldest month isotherm of 50° F. Prior to the development of efficient refrigerated transport, it was expedient to grow citrus fruits as close as possible to the manufacturing areas of the north middle latitudes. Tropical fruits are thus grown on the fringes of the tropics and are marginal from the point of view of the trees' climatic requirement. Growers have, however, improved varieties and perfected techniques of production under these conditions to such a degree that these areas control the world market for citrus products. Ackerman, writing on this theme, says :

> " We have pushed citrus cultivation closer and closer to our markets and farther from the native tropical habitats of these fruits, and have shaped the product more to our liking. But in so doing we have struggled more and more with climate until we now produce citrus fruits much less economically than we might. And now that problems of transportation in tropical climates have been solved, there is little excuse for nursing middle latitude groves through frosty winters. Increase in demand logically should be met from the rainy tropics where neither heater nor pipe line is required. The most intense cultivation of a plant rarely continues on the margins of its natural range ; hence, some of the elaborate and ingenious adaptations of citrus fruit growing to climate may become things of the past."

We may not agree with Ackerman's view with respect to the future development of world citrus in relation to climate, but his comments are illustrative of the type of change in the distribution of fruit growing areas which should be expected to result from modern developments in refrigeration and transport.

Within each producing country, knowledge concerning the suitability of local areas for the cultivation of different fruit varieties is only gradually accumulated by experience. In Europe, for instance, each of the numerous grape varieties grown has its own particular recognized district where special and definite conditions of soil and climate are found. The various varieties are markedly segregated. In those parts of the younger countries generally suitable for the culture of temperate and subtropical fruits, the procedure in the early days was to plant more or less indiscriminately a wide range of different fruit varieties. In the course of time, and as a result of experience and other factors, the various fruits have become redistributed and the cultivation of different varieties more and more segregated on those soil types, and under those conditions of climate more nearly suited to them.

* A paper read at the Adelaide meeting of the A. & N.Z.A.A.S., August, 1946.

In California, the areas considered suitable for different fruits are now (compared with South Africa and Australia) rather sharply defined and delimited. The topography of the country which results in marked differences in climate within a relatively small area greatly assisted this early differentiation between the location of various fruit varieties.

In Australia and South Africa, redistribution of fruit varieties to those areas most suited for their cultivation has not progressed so far. The history of the cultivation of the Navel orange in South Africa is a good example of how experience ultimately teaches. After the last war, the Navel orange was planted widely in South Africa and over an area extending 2,000 miles north and south, several hundred miles east and west, from sea level to 3,500 ft. elevation. Most of these areas were suitable for some one or other of citrus varieties, but very few locations were suited to the Navel. As Clark Powell said in 1933, thousands of Navels have been pulled out, top-worked or abandoned, and many thousands more will eventually meet the same fate.

In California, within a radius of 100 miles of Los Angeles, there are definitely recognised Navel and Valencia districts.

It is therefore most necessary that we should review carefully the present distribution of citrus varieties (and all fruit varieties) in Australia and determine as accurately as possible how far this distribution conforms with the requirements of soil and climate for each of the principal varieties grown. The task, however, of defining these conditions of soil and climate, and particularly of climate, which are most suited for the cultivation of each variety of fruit, is most difficult. A good deal of knowledge has been accumulated regarding the climatic requirements of the various types of citrus fruits. Much of this knowledge has been obtained by experience rather than by investigation, and at present is not adequately collated or systematized. Generally, the consideration is under "what range of climatic conditions may citrus be grown" rather than what are the optimal conditions for the growth and development of the various main varieties. Further, possibly nine-tenths of the literature upon the climatic relations of citrus concerns frost incidence damage and control because minimum temperatures have been limiting climatic factors in "middle latitude groves".

The Climatic Requirements of Different Varieties of Citrus.

A careful examination of the climatic conditions obtaining in those areas where the main varieties of citrus do particularly well should first be made. By comparing these conditions with those obtaining in other areas where other varieties are most favoured, and by collating published information on the climatic requirements of citrus types, more precise understanding of the requirements of the main varieties may result. A survey was therefore made of the distribution of the principal citrus varieties in the main citrus growing areas of California, Florida, Texas, Palestine, Italy, Spain, Brazil and South Africa, and the climatic conditions in each compared. For instance, the climates of those districts where Navels do particularly well, such as the Navel districts of California, the Sao Paulo area of Brazil, the Valencia province of Spain, the Cape Province and Natal areas of South Africa, and the Lower Murray Irrigation Settlements of Australia, were compared with each other, and with the climates of other districts in the same countries where Valencias or other varieties were most favoured.

The results of this survey show generally that:

(1) Minimum temperatures are important in that they limit successful cultivation. Differences in resistance to cold between different types are reflected in their distribution; limes are least capable of withstanding minimum temperatures, lemons less so and oranges more resistant.

(2) Maximum temperatures rarely seem to limit successful cultivation.

(3) Rainfall is unimportant, provided any deficiency in soil moisture supply is provided for by irrigation.

(4) Humidity is important in that it very materially affects the quality of the fruit and not all varieties to the same extent or even in quite the same manner. Generally speaking, under conditions of low humidity, colour is well developed and the fruit of good, clean outward appearance. Under conditions of high humidity, the rind tends to be thinner, and the fruit juicier, which means good internal quality, but, because of a higher incidence of insect and fungal spotting and blemishing, a poorer external quality.

(5) An important, and generally underrated or overlooked factor, is exposure to wind, shelter very considerably enhancing yield and quality.

(6) The most important factor, however, that seems to determine the distribution of different varieties is the total amount of heat received during the growing season. A good index of this factor is obtained by summing the degrees of mean temperature above the minimum required for citrus growth which is about 55° F., i.e. by taking as an index of available heat the summation of all the mean daily temperatures above 55° F. We find that the heat index calculated in this way for the main grapefruit producing areas ranges from 4388 to 8172, whilst the mean figure for the grapefruit areas of Texas, Arizona, Florida and California is about 6300. The index for the Navel areas ranges from 2700-3400, though they are mostly within the range 3050-3400, while lemon areas average a lower index still.

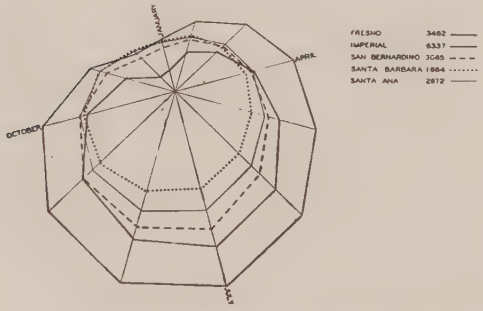


Figure 1.

Mean monthly temperatures and heat indices for five citrus centres in California plotted in the form of a clock chart. The centre of origin represents 50° F.

Relation of Heat Received to Distribution of Citrus.

The distribution of grapefruit, Navel and Valencia oranges and lemons in California illustrates the relationship. The mean monthly temperatures for five representative locations are graphed in Figure 1 and the heat indices shown in the legend. Imperial in the Imperial Valley has an index of 6337. The figure for Indio in the Coachella Valley is 6781 ; 82 per cent. of the citrus plantings in the Imperial Valley are grapefruit and of the Californian total 72 per cent. are grown in the area represented by the Imperial and Coachella Valleys. The figure and graph for Imperial, therefore, represents the Californian grapefruit areas pretty well. In the San Bernardino-Riverside area and Fresno districts, 72 per cent. of the Californian Navels are concentrated, and of all the citrus plantings in these areas 76 per cent. are Navels. Santa Ana, Orange County, is likewise representative of the Valencia district, and Santa Barbara of the lemon areas. Actually, 95 per cent. of the citrus plantings in Santa Barbara county are lemons, although the bulk of lemon plantings is distributed throughout the cooler parts of the Valencia areas.

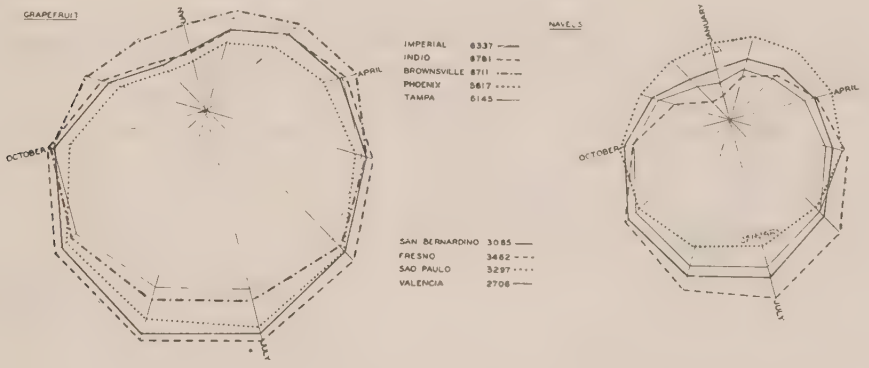
Grapefruit.

In Figure 2 the mean monthly temperature and heat indices are given for five grapefruit areas—Imperial and Coachella Valleys in California (Imperial and Indio),

Brownsville, Texas, Phoenix, Arizona and Tampa, Florida. The mean index of these areas is approximately 6300. Of the grapefruit grown in U.S.A., approximately 56 per cent. is produced in Florida under conditions of natural rainfall and high humidity, and fairly even annual temperature conditions, while the remaining 44 per cent. are produced under conditions of low humidity, irrigation and more extreme summer and winter temperatures in California and Arizona and intermediate conditions in Texas. The common climatic feature is the high total heat index the range of which, except in Arizona, lies between 6000 and 6700. In 1937, production of grapefruit in the States constituted 89 per cent. of world production. Other grapefruit producing countries arranged in the order of the amount of their production were Palestine (Jericho, index 6966, Haifa, 5179), Puerto Rico (San Juan, 4388), Brazil (Rio, 6496), Trinidad (8172) and Cuba (Havana, 8167).

Navels.

In Figure 3 the mean monthly temperature graph and heat indices are given for four Navel areas. Note again the even temperature of Sao Paulo compared with the decidedly lower winter and higher summer temperatures of Fresno. To these locations we might add Pt. Elizabeth, Cape Province, South Africa (3123), or Berri, South Australia (3020). Good Navel areas are all alike in one respect, the heat index is somewhere near 3000-3400.



Figures 2 and 3.

Mean monthly temperature and heat indices for five grapefruit producing, and on the left with the lower legend, four navel producing areas. For Sao Paulo the winter month of July is plotted on same radius as the winter month of January for stations in the northern hemisphere.

Comparisons with Australian Conditions.

In Figure 4 the composite graph for the four previous Navel locations is compared with that for Berri. For Navel production and quality the irrigation areas of the lower Murray are outstanding and the temperature condition of the location for Navel production conforms closely with those which a survey of the best Navel areas overseas would indicate as most desirable.

Valencias, lemons and mandarins may be treated somewhat similarly. Possibly the most interesting other example that can be taken for comparison of Australian and overseas areas is the grapefruit. It has been shown that in U.S.A. and overseas grapefruit is grown under conditions with a temperature index of 6000 or greater. In the desert areas of high summer heat and low humidity, very good quality fruit is produced, particularly from the point of view of external appearance. Fruit from

these areas supplies the main fresh fruit market. The major portion of the output in Florida, on the other hand, where conditions of high humidity lead to considerable spotting and skin blemish, is canned or used for juice.

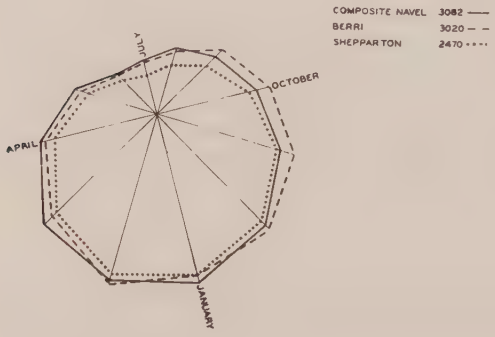


Figure 4.

The monthly temperatures averaged for the four navel areas represented in Figure 3, compared with the mean monthly temperatures for Berri, S.A., Shepparton, Vic.

In Australia the temperatures of none of our southern citrus areas approach those of the overseas grapefruit areas. Berri, with an index of 3020, Shepparton (2420), Griffith (3197), Mildura (3418) and Maitland (3573) fall far short of the average overseas (6000).

Bourke, with an index of 5148, approaches the conditions of the desert areas in U.S.A. By going to Queensland we may parallel the natural rainfall with high humidities and high temperatures of Florida and coastal Brazil.

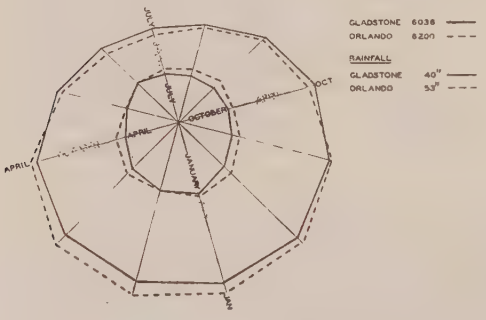


Figure 5.

The mean monthly temperatures, heat indices and rainfall for Gladstone in Queensland and Orlando in Florida compared.

The indices as shown in Figure 5 compare well and the rainfall, though lower at Gladstone, is reasonably evenly distributed as in Florida. Further north in Queensland the heat and rainfall progressively increase but the rainfall index becomes more markedly seasonal.

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A Yield Trial of Top Crosses between a Victorian Strain of Funk's Yellow Dent Maize and Twelve American Inbreds

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In connexion with studies on root, stalk and ear rots of maize, seed was obtained in 1940 of twelve inbreds commonly used in American hybridization programmes at that time, primarily because some of them were claimed to be more or less resistant to these diseases. Inoculation experiments during two seasons at Canberra failed to reveal any greater resistance in these inbreds to artificial inoculation of their ears or stalks with *Diplodia zeæ* or *Gibberella zeæ* than was shown by Victorian commercial varieties. As very little natural infection took place in these experiments, it is not known whether the inbreds are resistant to natural infection under local conditions. More interesting results were obtained from a trial of their influence on the yielding capacity of top crosses with a standard commercial variety. This trial is the subject of the present paper.

Experimental Technique.

During the 1941-1942 season, top crosses were made between each of the inbreds and single ears of a good commercial open-pollinated strain of Funk's Yellow Dent, obtained from Orbost, Victoria. Individual ears of Funk's Yellow Dent were bagged and hand-pollinated, each with pollen collected from a single inbred plant. Seed from each of these ears was tested separately. Owing to war conditions, these top crosses were not tested till 1945. It was then impracticable to test them elsewhere than at Canberra. As they were intended for growth on the rich soils of the Gippsland river flats, six cwt. of mixed fertilizer per acre was applied to the experimental area. This was on second-class hill land at Black Mountain, Canberra, and had grown potatoes, to which four cwt. of mixed fertilizer per acre had been applied, the previous season.

The seed was sown on October 25th and 26th, 1945, and the crop was harvested on May 21st, 22nd and 23rd, 1946. Four replications of each top cross were sown in randomized blocks, together with eight replications of the female parent (Funk's Yellow Dent) and four of Krug Corn (another open-pollinated variety from Orbost) as controls. Each replicate consisted of one row of fifteen plants spaced one foot apart, the rows being four feet apart. Fertilizer was applied as a side dressing when the plants were about six inches high. No organic manure, except about twenty per cent. of blood and bone in the mixed fertilizer, was used. The plots were irrigated whenever necessary, at first by sprinkling and later (when the plants exceeded two feet in height) in furrows.

The yields were determined as follows: all ears from each replicate were dried in a stream of hot air, threshed, and 50-gm. samples of the grain were dried to constant weight at 105° C. The weight of grain per replicate was adjusted to fourteen per cent. of moisture (expressed as a percentage of oven-dry weight) and the yield calculated in bushels per acre, taking 56 lb. as the bushel weight. The significance of the results was calculated by Mr. G. A. McIntyre, biometrician, who also checked the method of determining yield.

Results.

Only two of the inbreds, K4 and 38-11, produced top crosses that gave substantial increases in yield as compared with the controls (Table 1). They are both late-maturing inbreds, and are reputed to be resistant to ear rot.

TABLE 1.

Yields of Top Crosses between Two Inbreds and Funk's Yellow Dent Maize, Compared with the Yields of the Same Strain of Funk's Yellow Dent and of Krug Corn.

Inbred Parent.	Yields from Individual Crosses, in Bushels per Acre (each the Average of Four Replicates).	Average Yield of all Crosses in Bushels per Acre.	Significance of Difference between Average Yield and that of F.Y.D.
(1) K4 ..	133·5, 154·8, 144·5*	144·3	$P<0·001$
(2) 38-11 ..	143·8, 132·5, 122·8, 129·5, 125·0, 130·5*	130·7	$0·001<P<0·01$

* Differences between the yields of individual crosses are not significant. Each figure for yield in this column is from plants grown from seed from a single top-crossed ear of Funk's Yellow Dent.

Significance of difference between average yields from (1) and (2): $0·02<P<0·05$.

Average yield from 8 replicates of Funk's Yellow Dent: 106·6 b.p.a.

,, ,, ,, 4 ,, ,, Krug Corn: 108·5 b.p.a.

The top crosses from inbred K4 gave an average yield about 34 per cent. above that of the controls and significantly higher than those from inbred 38-11, which averaged about 21 per cent. above the controls. The K4 crosses were also slightly earlier maturing than the 38-11 crosses, an important point under Victorian conditions, where most hybrids so far tested have been too late to ripen satisfactorily before the first autumn frosts. The K4 crosses did not appear to be very much later than Funk's Yellow Dent. Both series of crosses tended to sucker freely and to produce many small to medium-sized ears, borne high on the stalks, an undesirable character in that it increases the difficulty of harvesting.

The remaining ten inbreds used for top-crossing with Funk's Yellow Dent were M14, H5, 4-8, L, R4, three lines of Hy from different sources, 187-2 and Kys. The yields from their top crosses with Funk's Yellow Dent either were not significantly different from those of the controls, or showed only a slight increase. The three top crosses with 187-2 were the most promising, apart from those with K4 and 38-11. They averaged 115 bushels per acre, and ripened earlier than the controls.

Discussion.

In Rhodesia, where it has not yet been practicable to undertake the breeding of single or double cross-hybrids for local conditions, a scheme has recently been outlined for the use of top crosses between inbreds and local open-pollinated varieties.[1] The results described above suggest that a similar scheme might be worthy of investigation for parts of Australia such as Gippsland. Here the maize-growing industry is of considerable local importance, but may not be large enough to justify a full-scale breeding programme, involving the development of inbreds from local varieties, and their combination to produce single and double cross hybrids.

Bulk supplies of top-crossed seed can be produced much more quickly and at a much lower cost than double-cross hybrids, by using existing inbreds, growing the male (inbred) and female parents together in a plot isolated from other maize, and removing all tassels from the female parent before any of their pollen is shed. It is possible that top-crossed seed might, to a limited extent, make available some of the benefits of hybrid maize to growers in Gippsland or other regions, where it may not be practicable to use the ordinary types of hybrid maize. The results cannot be expected to be as uniform or as good as those from single or double cross hybrids, since the only control over the uniformity of the female parent is that of annual mass

selection. Only two of the twelve inbred lines used by the writer gave substantial increases in yield, and these two imparted certain undesirable characters to their top cross progeny, as mentioned above. However, the inbreds used represent only a very small proportion of the number now available.

The cost of producing top-crossed seed would, of course, be considerably greater than that of producing open-pollinated seed. It seems likely, however, that growers on rich soils could afford to pay high prices for top-crossed seed and still show a handsome profit. In a good season yields of 100 bushels per acre, without fertilizer, are not uncommon on alluvial soils in East Gippsland. Under these conditions, even a ten per cent. increase in yield from top-crossed seed would return £2 10*s*. 0*d*. per acre gross extra profit, taking the value of maize grain as 5/- per bushel and neglecting the additional cost of handling the extra yield. Since a bushel of seed will sow five acres or more, the gross extra profit would repay the cost of top-crossed seed up to £12 10*s*. 0*d*. per bushel above that of ordinary seed, under these conditions.

It is emphasized that the object of this paper is merely to illustrate the possibilities of top-crossed seed. No claim is made that the top crosses referred to above would yield as well in other districts as they did at Canberra, or that they would necessarily be suitable for commercial growers with regard to characteristics other than yielding capacity.

Summary.

Top crosses were made between Funk's Yellow Dent maize from Victoria and each of twelve American inbreds. Top crosses from two of these inbreds gave yields of grain averaging 34 and 21 per cent. higher than the yields from Funk's Yellow Dent and Krug Corn in an irrigated field test at Canberra. Top crosses from the other inbreds had no special merits.

It is suggested that these and other top crosses between existing inbreds and local open-pollinated varieties may be worth investigating as a possible substitute for single or double cross hybrids in maize-growing areas such as Gippsland, where the acreage grown may not justify a full-scale programme of inbreeding, single and double crossing.

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Some Aspects of Barley Breeding

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Because of the importance of the wheat crop in Australian agriculture, and the necessity of providing suitable varieties for its establishment, expansion and maintenance, barley has received scant attention, and the grower today is largely dependent upon the varieties of half a century ago. A second reason for the apparent neglect of the plant breeder lies in the inherent nature of the barley plant itself—the extraordinary powers of adaptability exhibited by the species as a whole.

Because of the failure of imported varieties of wheat to adapt themselves to local conditions generally, and to those prevailing in the lower rainfall areas in particular, the breeder was, from the outset, faced with the problem of establishing economic yield levels—of developing new varieties suited to the local environment. In the case of barley, however, this problem did not arise ; the standard varieties Prior and Cape, which together occupy between eighty and ninety per cent. of the total Australian barley acreage, were imported ready made. This fact is amply demonstrated by the malting variety Prior, which returns profitable yields over a rainfall range of less than fourteen to more than forty inches. A somewhat similar degree of adaptability is exhibited by practically every other variety at present under cultivation here.

Because the imported article has proved so amenable to local exploitation, it is small wonder that so little attention has been afforded the improvement of this, the third most important Australian cereal crop. It is really only in recent times that barley breeding has received any serious consideration, yet, although the fringe of the field has been but barely exploited, the results obtained to date are sufficient to warrant the greatest optimism regarding the future.

Any consideration of the problem of barley improvement must naturally embrace the two species *distichon* and *vulgare*, the malting and the feed types. The problems presented by these are, with the possible exception of grain quality, essentially similar, and involve such characters as resistance to disease and drought, adaptability, time of maturity, strength of straw, and awn characteristics.

Two problems which are in need of most urgent attention are those relating to the improvement of the malting quality of the grain, and the production of varieties resistant to disease, particularly to covered smut (*Ustilago hordei*). Local varieties are at best of mediocre quality, and in addition, are generally susceptible to disease. Because of this, both these problems should take precedence over that of improving yielding capacity. It is not suggested that yield should be sacrificed at the altar of quality ; on the contrary, improvements in grain quality or in any other direction must be achieved irrespective of and not at the expense of yield. The fact remains, however, that we have our basic yield levels established on a satisfactory plane, while existing quality levels are far from satisfactory. Although the ultimate yield level has probably not been attained, nor is yet in sight, it is apparent that existing yield levels are sufficiently attractive to warrant the diversion of the breeder's attention to the problems already referred to. If improvements can be made in both directions, and there is nothing to suggest that they cannot, so much the better. In any case any long-range programme must make provision for the improvement of yielding capacity, since, after all, this represents the ultimate objective of the breeder.

Improvement of Malting Quality.

The question of malting quality is all important to the Australian barley grower. The problem of investigating and improving quality is a particularly fascinating one, full of absorbing interest, and in some aspects conducive to an outside in headaches

to the investigator. Malting quality in barley is essentially the expression of the end point of a particularly complex varieto-environmental reaction. A thorough understanding of this reaction, and of the nature and extent of influence of the factors involved is a prerequisite of the successful breeder of malting barleys.

Quality is determined by such factors as soil, season, climate, cultivation, manurial practice and variety, all of which exercise a differential effect in its determination. With the exception of the varietal influence, all of these may seem to be beyond the control of the breeder, yet, in reality, he can overcome them to a certain extent by the breeding of varieties for specific conditions, as for example, barleys for clay soils or for loams, types for Yorke Peninsula, for the Victorian Mallee, or for the higher rainfall areas as typified by the south-eastern barley belt.

Any detailed discussion of the characters constituting good malting quality would be out of place here, but it may be of interest to outline very briefly the standards required by the malting trade. The requirements laid down by the Institute of Brewers in England are as follows : " Grain grown on barley land, well ripened, of good shape, uniform, carefully threshed, thoroughly sound, free from weed contamination, having a nitrogen content not exceeding 1·6 per cent. and capable of producing a first class malt." From this definition two factors emerge which are of immediate interest to the barley breeder—grain shape and grain nitrogen content. Both are varietal characteristics, and both exert a profound influence in determining malting quality. Of the two, grain nitrogen content is the more important and, in fact, furnishes the most reliable measurable index of quality. Though profoundly influenced by environmental factors, grain nitrogen is essentially varietal in character, and as such is available to the breeder. Some idea of the varietal effect upon this character may be gained from the results of thirty-three Victorian trials with the varieties Plumage Archer, Spratt Archer and Prior, the average grain nitrogen figures for these being 1·22 per cent., 1·35 per cent. and 1·53 per cent. respectively.

The scope for improvement in regard to malting quality is tremendous. The main standard malting variety, Prior, while possessed of a degree of adaptability that enables it to thrive over a wide range of conditions, produces at best a grain of only mediocre quality. The reason for this lies in the inherently high grain nitrogen level, and in the general harshness of the grain itself. On the other hand, a second standard variety, Plumage Archer, is much less adaptable than Prior, and being of later maturity, is more susceptible to hot winds in the late spring. Because of this, its sphere of usefulness is limited to the better rainfall areas. Plumage Archer, however, possesses one outstanding attribute, high malting quality—a characteristic of the Goldthorpe or erectum barleys—which it retains under all but the most adverse conditions.

With these two varieties to hand the obvious course open to the plant breeder is to mate them with the object of combining the adaptability, earliness of maturity, and superior grain size of Prior with the inherent malting quality and generally superior grain characteristics of Plumage Archer. By back crossing to the Prior parent, no difficulty should be experienced in the selection of superior malting types for the more favoured of our barley districts. As an example of what may be achieved in this direction we have the Victorian variety Research, the progeny of a Prior × Plumage Archer mating.

The production of malting varieties for the drier areas, and this is a very real problem in the Victorian Mallee, will entail the introduction of an even more pronounced degree of earliness of maturity than that exhibited by Prior. To obtain this the breeder will have to explore the possibilities presented by the barleys of such countries as India, Egypt and Arabia. The employment of these types in the breeding scheme introduces certain difficulties, since they are mostly characterized by a harsh unattractive grain which is hard to eliminate. By the judicious use of the back cross, however, the problem should be overcome, and by utilizing grain

nitrogen as a guide to selection, the breeding of early maturing high quality strains should be greatly facilitated.

Disease Resistance and Other Characters.

The second problem requiring attention is the production of varieties resistant to covered smut. The problem is particularly urgent, since many otherwise excellent samples of grain are each year rendered unsuitable for malting as a result of smut contamination. This leads to a marked depreciation in value with a consequent loss to the grower. However, the position is distinctly hopeful and, with resistant parent material available, there is no reason why the entire range of Australian malting and feed barleys should not be smut resistant. The outlook with respect to most of the other common diseases of barley is very similar, since, with the exception of the foot rots, resistant parent types are available. The breeding of resistant strains may in some cases involve difficulties in the development of an efficient inoculation technique, but there can be little doubt that these will be overcome with the cooperation of the plant pathologist.

Other possibilities, which the barley breeder may and should explore, relate to the development of smooth awned and awnless barleys, and the breeding of early varieties for forage purposes. In addition, straw characters require attention, particularly with regard to resistance to lodging, and the elimination of the " neck-break " so common in the cultivated barleys.

Organization of a Barley Improvement Programme.

Quite apart from the possibilities presented by hybridization and selection as a means of improvement, the introduction of new types from other countries provides a wide field for investigation, which should be exploited to the fullest extent. The initial step in any breeding programme must be the accumulation of an extensive varietal collection, from all available sources, to serve as a reservoir of potential parent material. In this regard it will be found that the barleys from different areas exhibit distinctive characteristics which may be of value to the breeder. For example the Mediterranean countries generally are characterized by early drought-resistant types, England and Czechoslovakia by mid-season malting types, Japan by short, strong-strawed barleys, while the most prolific source of disease-resistant material is probably the United States of America.

In conclusion it would be wise to stress the fact that, to be successful, the barley improvement scheme must be organized and developed along sound lines. This will involve the careful planning of the hybridization programme, and the selection of suitable parent material ; the organization of facilities for the testing of hybrid material for grain quality, the development of efficient inoculation techniques, and the establishment of disease nurseries for the selection of resistant strains ; and finally the establishment of regional selection centres and variety testing stations to provide for the conduct of final yield trials, and for the maintenance of pure lines of seed for distribution to farmers.

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Technical Notes

A NON-SWEATING CHEESE FOR THE TROPICS.

There has long been a need for a cheese which would be as attractive to eat in the tropics and areas of hot summers as is ordinary cheddar in temperate climates. Cheddar cheese, as is well known, " sweats " freely when atmospheric temperatures are high, and its edible life is very short where refrigeration is not available ; processed cheeses do not lose so much fat, but they usually lack the rich flavour of matured cheddar. The presence of large bodies of troops in the tropics and a shortage of refrigerated shipping space gave urgency to the demand for a non-sweating cheese, and this Department, in conjunction with the Queensland Butter Board, initiated researches with that end in view. Successful results were obtained, and to date a total of approximately one hundred tons of this " homogenized " cheese has been manufactured. Furthermore, large consignments are at present being prepared for despatch to tropical areas.

The principle underlying the manufacture of this new cheese which shows such a resistance to fat flow at high atmospheric temperatures is the homogenization of the fat particles to the stage when the globules are less than two microns in diameter and do not exhibit any tendency to clump. In practice it has been found that the cream has first to be separated from the milk, then homogenized and reconstituted with skim milk, since treatment of the whole milk leads to a physical breakdown of the casein and a consequent soft curd.

Manufacture.

It was found necessary to carry out the homogenization of the cream in three stages ; the first at high pressure to split the globules, and the second and third at lower temperatures and with an emulsifying agent to cause a complete dispersal of the globules. Using a cream of 20 per cent. butter fat the first stage would be effected at a pressure of 2,200 lb. per square inch with the second and third at 650 and 150 lb. respectively ; the addition of 0·75 per cent. sodium citrate is used as an emulsifier in the last two stages. The number of phases, the pressures and temperatures used, the quantity and type of emulsifier, the acidity and fat content of the cream, and the practice of using calcium salts in casein-deficient milk, were all found to be important factors in the success or otherwise of the homogenization process. The final result of homogenization should be a dispersion of fat globules all less than two microns in diameter and showing Brownian movement ; if any clumping is evident there is a thickening of the cream and an increased fat leakage in the final product. When the homogenized cream is mixed with the skim milk each globule of fat is completely enclosed by the curd phase—the smaller the fat globules and the greater their dispersion the more effectively are they permanently enclosed in the reconstituted milk and the less does the fat leak from the resultant cheese.

The tremendous increase in surface area of the fat following homogenization alters the physical characteristics of the reconstituted milk so there are reduced fat losses and increased yields of cheese ; on the other hand, fat-splitting enzymes react very rapidly on the huge surface exposed and the temperature must be maintained at a sufficiently high level to render them inactive. It is advisable to maintain a temperature of 160° F. throughout the treatment of the cream to ensure complete destruction of these enzymes, and for best general results it is preferable to carry out the whole process from pasteurization of the whole milk to the reconstitution of the milk at the same temperature. The increase in fat surface also gives rise to difficulties in the control of the moisture content and cooking temperatures 2° to 4° F. above normal are necessary.

Further alterations in manufacturing technique found necessary included the use of a heat-resistant starter (*Streptococcus thermophilus*) in association with the

normal lactic culture, an increase to double the usual quantity of rennet, lower acidities in manufacture and a cooking time extending to 40 or 50 minutes with rennetting or setting temperatures approximately 2° F. higher than normal. In addition, since the curd is a soft type, it must be cut more finely and handled more gently during treatment.

In checking the reconstituted milk it was found essential to use the butyl alcohol modification of the Babcock test and with 4 ml. to 17·6 ml. of reconstituted milk there was no difficulty in obtaining clear, char-free fat columns. The same amount of alcohol also gave good results with 9 gm. of homogenized cream or 9 ml. of whey.

Analyses of cheeses made from homogenized milk give results comparable with those from normal cheddars.

Discussion.

Experiments with this new cheese have demonstrated that after prolonged holding at temperatures ranging from 100° F. to 130° F. there is negligible sweating of fat and that shape, condition and appearance are maintained. Under the same conditions normal cheddar exuded fat profusely under 100° F. and at 120° F. became misshapen and finally a molten mass. Some actual figures obtained are summarized below.

Temperature.	Incubation Period.	Loss in Weight.	
		New Cheese.	Normal Cheddar.
105° F.	6 hours.	Negligible.	6%
106° F.	24 hours.	0·5%	10%

The results from approximately 100 vats have indicated that there is an appreciable increase in yield from the homogenization process when compared with normal methods. Fat losses in the whey are considerably reduced, effecting a saving of up to eight per cent. of all fat received. Moisture contents show an appreciable increase and the cheese shows a much more rapid rate of maturation, developing a characteristic matured flavour in four to six weeks compared with four months for normal cheddar. The treatment of the milk and changes in manufacture combine to improve the bacteriological and keeping qualities of the cheese and gradings and keeping quality compare more than favourably with cheddar.

It is estimated that under commercial conditions the cost of manufacture of this cheese is 25 per cent. greater than for ordinary cheddar, but increased yields, reduced fat losses and a more rapid ripening more than compensate for this, and ultimately the price should not be much above that for cheddar.

It is considered that this cheese will fill a long-felt want and, providing it is offered in a hygienic and attractive form, should prove popular with consumers in the warmer parts of Australia.

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ARTIFICIAL PARTHENOCARPY IN THE TOMATO.

Trials with blossom sprays of growth substances to promote parthenocarpic set in glasshouse-sown tomatoes have been carried out on the Adelaide Plains this season. In this area natural pollination fails during the cold winter months and although the tomato will grow and flower freely in unheated glasshouses, the fruit set between late May and early September is most unsatisfactory.

Tests were begun in mid-June. Conducted at first on a small scale, they were increased in scope as the limit of safe treatment was determined, and terminated in a trial on a commercial scale in which four sixty-foot houses planted to variety Early Dwarf Red were used. The results obtained are shown in Table 1.

TABLE 1.

The Average Set of Fruit Counted at Random in Glasshouse Tomatoes at Lockleys Fourteen Days after a Single Blossom Spray with β Napthoxyacetic Acid. Twenty Plants Counted in each House.

Treatment.	Mean Number of Fruit Set per Plant.*	Spray Solution Used in Treating House. Gallons.	Labour Expenditure in Treatment. Man Hours.
House 1. Blossom spray of β napthoxyacetic acid, 100 p.p.m. in water..	11·1	1·6	2·17
House 2. Untreated	0·15	—	—
House 3. Blossom spray as in House 1	6·8	1·15	2·0
House 4. Untreated	0·25	—	—

* The standard error for the mean number of fruit set was ±0·74.

Note.—Houses 1 and 2 are comparable and of identical history and treatment. Houses 3 and 4 are comparable and about 10 days later than 1 and 2.

Growth substances were applied to the open blossom in aqueous solution, by means of a hand atomiser spray. Flowers from which the petals had fallen rarely set, but open flowers and advanced buds responded rapidly, the carpels expanding quickly while the corolla persisted. The style in parthenocarpic fruit characteristically remains green, and in a high percentage of the fruit the stylar end of the fruit has become protuberant. As all carpel lobes have expanded evenly the fruit is quite characteristic in shape and differs markedly from the normal flat irregularly lobed fruit from natural setting. No fruit has ripened as yet but studies of differences in quality and character will be made when the crop reaches maturity.

β-Naphthoxyacetic acid was the only substance of those tested which could be used without growth distortion and interruption to the subsequent plant development. With this substance at 100 p.p.m., there was still notable shock and the plants wilted and blossom closed, but the plants recovered in two or three days.

Other substances tested, which were active in inducing parthenocarpy were :

2, 4, dichlorophenoxy acetic acid. At 10 p.p.m. this substance very severely distorted growth and subsequently growth was weak with little further blossom. Tests at lower concentrations are not complete.

2, 4, 6, trichlorophenoxy acetic acid. At 50 p.p.m. stems became brittle and leaves inrolled, new foliage being reduced to little more than the mid-rib.

Nine other preparations tried did not show parthenocarpic activity comparable with these three.

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THE TOXICITY OF "666"* TO PREPUPÆ OF *LUCILIA CUPRINA*.

Whilst engaged in experiments to determine the larvicidal value of the synthetic insecticides D.D.T. and "666" as a stomach poison against early third instar larvæ of *L. cuprina*, it was observed that the majority of the larvæ failed to complete their normal development when placed on to finely chopped liver containing 0·1 per cent. "666" (W/W).[1] The reaction of the larvæ to this insecticide in these studies suggested that "666" might be acting as a contact larvicide. Accordingly a series of trials were conducted to determine its mode of action against prepupæ.[2] This paper details the results obtained from three experiments in which prepupæ were placed in contact with wool which had been treated with "666". Prepupæ were used in this work as it is known that resistance of larvæ to contact agents increases with age. Furthermore, they are less likely to be affected by handling than larvæ and are at a non-feeding stage of development.[3]

Methods.

Prepupæ were obtained from cultures of *L. cuprina*, fed on beef steak and maintained at 75° F. in an incubator.

Bulk samples of wool were thoroughly soaked by steeping in 700 c.cs of either "666"-xylol-water or xylol-water emulsion. Excess moisture was removed and the wool air dried for at least ten days before the commencement of an experiment. The "666"-xylol-water emulsion was prepared at 0·5 per cent. and 0·1 per cent. concentration from a stock solution of "666" in xylol with a suitable emulsifier by the addition of 1 part of the solution to 140 and 700 parts of water respectively. The xylol-water emulsion was made by adding emulsified xylol to water in the proportion of 1 part of xylol to 140 parts of water.

Approximately 0·5 gm. of well-teased wool was drawn from the bulk sample and arranged in each tin to cover the bottom. The tins, which were provided with closely fitting lids with wire gauze windows, were 2½ inches in diameter and 2 inches in depth. Twenty-five prepupæ were placed in each tin to which several drops of water were then added. After 24 hours moistened sand was run under the wool. The wool was left in the tins as handling of the prepupæ at this stage in separating them from the wool interfered with pupation. All experimental material was kept in an incubator at 75° F. with high humidity.

Each treatment was replicated three times and the experiment repeated thrice.

Results.

In Table 1, column A refers to the number of pupations and column B represents the number of dead prepupæ in the three replicates for each treatment in an experiment. This method of presenting the results was adopted because the lids of the tins permitted some prepupæ to escape during the course of the experiment and the final numbers were therefore not the same for each treatment.

It was observed that prepupæ placed in contact with 0·5 per cent. "666" emulsion treated wool became semi-paralysed and incapable of rapid locomotory movements within 48 hours. The majority of the prepupæ died over a period of three to eight days. The onset of paralysis of the 0·1 per cent. "666" treated wool was slower than at the higher concentration. The number of pupations recorded at 0·1 per cent. concentration was significantly higher than at 0·5 per cent. concentration. No attempt was made to estimate the rapidity of kill as it was not easy to determine when death had actually occurred.

Since prepupæ are the most resistant of the various stages of larval development it may be concluded that "666" in wool would be toxic to newly emerged larvæ at low concentrations.

* Benzene hexachloride (13 per cent. gamma isomer content).

The contact larvicidal property of " 666 " shown in these laboratory tests may be of practical value in the prevention of the spread of strike. Limited field trials with " 666 " have been carried out and samples of wool taken from the crutch area of ewes, which had been jetted five weeks previously with a 0·5 per cent. xylol " 666 " mixture, prevented prepupæ from developing completely.

The writer has carried out tests which indicate that " 666 " has not acted as a fumigant in these studies.

TABLE 1.

Showing Number of Pupations and Number of Dead Prepupæ.

Wool Treatment.	Experiment I.		Experiment II.		Experiment III.		Grand Total.	
	A.	B.	A.	B.	A.	B.	A.	B.
0·5% " 666 "-xylol emulsion ..	0	74	3	72	1	68	4	214
0·1% " 666 "-xylol emulsion ..	20	50	26	38	35	40	81	128
1 : 140 xylol emulsion	60	15	62	12	54	18	176	45
No treatment	55	15	57	13	55	20	167	48

Summary.

1. *I. cuprina* prepupæ fail to pupate when placed in contact with wool which has been treated with a 0·5 per cent. " 666 " xylol emulsion. In the experiments recorded in this paper four prepupæ only out of a total of 214 pupated in wool which had been treated with 0·5 per cent. " 666 " xylol emulsion.

2. More than 50 per cent. of the prepupæ fail to pupate in contact with wool which had been treated with 0·1 per cent. " 666 " xylol emulsion.

3. Since prepupæ are the most resistant of the various stages of larval growth it is likely that " 666 " at low concentrations would kill newly emerged larvæ as a contact larvicide.

4. Prepupæ do not feed. The " 666 " did not act as a fumigant. Hence it may be assumed that " 666 " has acted as a contact larvicide in these investigations.

5. Although the action of " 666 " against prepupæ is slow, the contact larvicidal property of this insecticide demonstrated in these laboratory experiments indicates that " 666 " may be suitable for jetting the breeches of ewes and applying to rams' heads for the prevention of fly strike. In limited field trials samples of wool taken from the crutch area of ewes, jetted five weeks previously with 0·5 per cent. " 666 "-xylol emulsion, were toxic to prepupæ.

6. The conclusion can also be drawn from these studies that " 666 " may prove to be an important constituent of blowfly dressings.

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A METHOD OF SELECTION WITHIN A VARIETY OF CABBAGE.

Cabbage is a cross-pollinated vegetable crop. Practically all varieties contain a range of genetic types. By repeated selection the present commercial strains have been produced, and these yield a high proportion of marketable heads when grown under the climatic and edaphic conditions of commercial districts. In districts not adapted for commercial cabbage culture, the proportion of heads typical of the variety is smaller and a wider range of types is present. Similarly, cabbages grown out of season are variable in type, with a low proportion of typical and of marketable heads.

A wide range of types is produced when the variety Succession is grown as a winter cabbage at Canberra. This site was chosen to examine two methods of selection within the variety Succession, under conditions climatically unsuitable for the commercial growth of most strains. Sixteen strains of the variety Succession, which had been chosen as well above average productivity, were grown at the Dickson Experiment Farm, Canberra, in July, 1944. One of these lines proved more productive than the others, and from the 500 plants of this line, plants for seed production were selected by the following methods:

(1) The seven plants truest to the varietal type in shape, size, colour, and in conformation of the outside leaves were transplanted to a shade house. No attempt was made to prevent cross pollination among the plants in this group, but the seed from each plant was harvested separately.

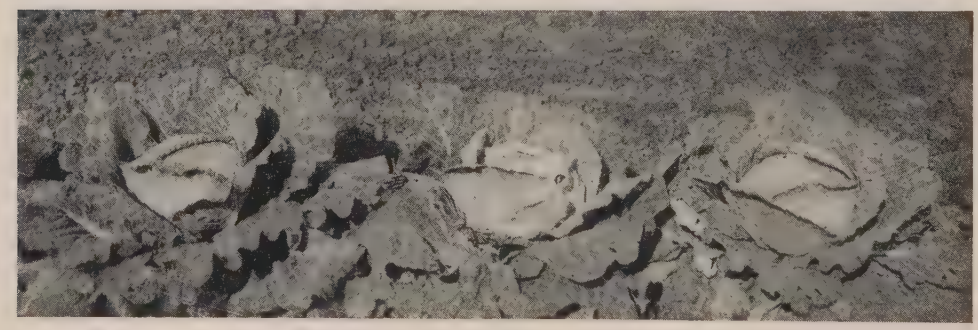

Figure 1.
Representative Marketable Cabbages from a "Single Plant" Selection.

Figure 2.
Representative Marketable Cabbages from the "Poor Plant" Selection.

Photographs by Mr. T. Pickard.

(2) 120 good type plants were transplanted into an isolated part of the field. Cross pollination occurred between the plants of this group, and the seed from all plants was harvested as a bulk sample. This method of selection is similar to the method of selection in practice for the production of commercial seed lines.

(3) As a contrast to the above methods, 24 very poor cabbages, including misshapen and round-headed types, together with leafy, small, and multiple-headed cabbages, were transplanted to a site four miles from the groups described above. The seed from these cabbages was harvested as a bulk sample.

In the following year, samples of seed obtained from the above methods of selection were grown, together with a standard commercial line, at Canberra and at Griffith in the Murrumbidgee Irrigation Area. 200 plants of each line were grown at Canberra, 60 at Griffith.

The percentage of heads typical of the variety, the percentages of marketable heads, and the widths, heights and weights of the cabbages were recorded. The mean figures for each selection are shown in Table 1

TABLE 1.

Growth Performances of Selections of the Variety Succession at Canberra, and at Griffith.

Site.	Selection or Strain.	Percentage of		Weight of Stripped Heads. (Kg.)	Ratio Width / Height	Yield. (Tons per Acre.)
		Typical Heads.	Marketable Heads.			
Canberra.	Commercial strain ..	7·5	67·5	1·0	1·6	4·3
	Poor plant selection ..	42·5	66·5	1·1	1·6	4·8
	Bulk selection ..	13·5	57·5	1·5	1·7	5·2
	Single plant selections.					
	1	53·0	73·0	1·3	1·8	6·1
	2	48·0	76·5	1·4	1·7	7·0
	3	40·5	72·5	1·6	1·8	7·5
	4	70·5	83·5	1·4	1·7	7·4
	5	76·5	86·5	1·6	1·8	8·9
	6	42·0	76·0	1·4	1·5	7·2
	7	43·0	66·5	1·5	1·7	6·4
Griffith.	Commercial strain ..	61·7	73·3	2·0	1·5	13·1
	Poor plant selection..	60·7	71·7	2·4	1·5	15·6
	Bulk selection ..	78·3	86·7	2·1	1·5	16·7
	Single plant selections.					
	1	58·3	70·0	2·3	1·7	14·8
	2	80·0	86·7	2·7	1·6	21·3
	3	69·0	78·3	2·5	1·6	17·8
	4	80·0	85·0	2·4	1·7	18·8
	5	68·3	80·0	3·3	1·5	24·3
	6	73·3	86·7	2·6	1·4	20·6
	7	88·3	93·2	3·0	1·6	25·7

Six of the strains, including the bulk plant selection, the poor plant selection, and the commercial strain, produced significantly more typical heads at Griffith than at Canberra. ($P<0·05$ by " t " test).

At Canberra, seed from the poor plants and from the bulk selection, as well as the commercial strain, produced significantly fewer heads typical of the variety

than were obtained from six of the seven single plant selections. Single plant selections Nos. 4 and 5 produced significantly more typical heads than any of the other lines, and significantly more marketable heads than six of the other eight lines.

At Griffith, the poor plant selection and the commercial strain produced significantly fewer typical heads than three of the single plant selections, and significantly fewer marketable heads than only one single plant selection—No. 7.

Under the conditions of this test the strain produced from a bulk selection of good plants was only slightly better than that from the poorest plants of the parent strain. The seed lines from the single plant selections, which had been made at Canberra, produced significantly more heads true to the varietal type, than did the commercial strain when both were grown at Canberra. When the same single plant selections were grown in comparison with the same commercial strain at Griffith, the differences were smaller and were, in many cases, not significant. This indicates that a cabbage strain may be improved by selecting outstanding plants and raising seed from these selected plants, care being taken to prevent cross-pollination with poorer plants or with other varieties of cabbage or allied plants. The improvement is most marked when the selection is made under similar conditions to those in which the strain is to be subsequently grown.

D. C. Wark.

Division of Plant Industry,
Council for Scientific and Industrial Research,
Canberra, A.C.T.

(Received for publication, 18th October, 1946.)

THE "WALLUM COUNTRY" OF QUEENSLAND.

"Wallum country" is a term loosely applied to the whole of the sandy coastal plain extending from the southern border of Queensland to near Rockhampton in central Queensland. It runs inland to the rising ground of the foothills and is broken in many places where they come down to the sea. Topographically it consists of low rolling ridges, sometimes only a few feet in height, separated by extensive areas of flat country usually termed "swamps" by the local inhabitants; within these "swamps" are a few true, wet swamps with water channels flowing sluggishly; also included in the plain are areas of true wallum country, i.e. land growing wallum (*Banksia æmula*) as its only tree species.

The sandy ridges carry a variety of eucalypts and a typical soil profile shows 12-15 inches of grey sand on 9-18 inches of yellow sand over a yellow sandy clay, which is quite often underlain by a mottled clay horizon. The parent rock is, of course, a sandstone. The tops of some ridges carry a deep, red, sandy loam which has been designated the "Glasshouse sandy loam" by Vallance. It grades imperceptibly into the other ridge soil type and is used largely for pineapple farming. In its natural state it supports a better type of eucalypt forest.

There is a transition in the soil profile from the ridges to the "swamps" where there is a depth of 48 inches of white sand over a compacted white sandstone on top of mottled sandy clay and the parent rock. As may be expected with such a depth of sand, these areas are dry and well-drained, except in persistently wet weather, and the vegetation is xerophytic. There are no trees and the flora consists chiefly of grass-trees, epacrids, *Hakea* and the low shrubby *Banksia latifolia*. In the true swamps the soil, a silt or clay loam, is characterized by melon-holes and supports a tree vegetation of *Melaleuca*.

The true wallum country, usually occurring in patches from a few to many acres in extent, has a ground cover of shrubs, such as *Boronia* and *Leptospermum*, with the spaced trees of the wallum giving a park-like appearance. It is typically a few

feet above the treeless swamps into which it often grades, and frequently occurs on the same level as the sandy ridge soils. The vegetation it supports is a xerophytic type. The soil profile consists of a black sandy humus horizon up to 18 inches thick grading into a white sand which is underlain at a depth of three to four feet by a hard black organic sandstone, ranging from a few inches to many feet in thickness. Beneath this layer the soil is again a white or yellow sand grading into a sandy clay and so into the parent sandstone. The soil is very acid, often having a pH of 3·5, and is very poor in plant nutrients; it does not appear amenable to any form of cultivation owing to its excessive drainage and the presence of the hardpan.

This black sandstone of the true wallum soil does not occur elsewhere on the coastal plain but it is interesting to note that it is to be found on Fraser Island and may possibly be a relic of a coastal uplift. On Fraser Island it is exposed in the sand-cliffs on the eastern side of the island and at sea-level on the west, and forms the bed of the freshwater lakes. It is suggested that, on the mainland at least, the sandstone associated with the wallum is in process of disintegration for it would appear that it could not have developed, nor is in process of development, in its present well-drained raised position. On exposure, the organic matter of the sandstone gradually disintegrates, the hardpan breaks down and plant roots are able to penetrate it. This process is apparently being carried out in situ and although definite proof is difficult to obtain, the indications are that the areas of this sandstone are decreasing in size.

Particular interest has been focussed on the coastal plain for the establishment of plantations of exotic conifers, and pilot plots and surveys have shown that the sandy ridge soils, with the addition of fertilizer, can be used in this manner, but the wallum country is most unpromising and the treeless areas are of very doubtful value.

Reference.

1. Vallance, L. G.: Q. Agric. Journ., 49: 554-579, 1935.

H. E. Young.

Department of Agriculture and Stock,
Brisbane.

(Received for publication, 21st October, 1946.)

The Australian Institute of Agricultural Science

TENTH GENERAL MEETING.

The tenth general meeting will be held at Science House, Gloucester Street, Sydney, on 21st March, 1947, at 7.30 p.m.

AGENDA.

(1) Minutes of ninth general meeting.
(2) Report of Council for the twelve months ended 31st December, 1946.
(3) Report of Editor and Business Manager of Journal.
(4) Statement of Accounts and Balance Sheet for 1946.
(5) Report of Council concerning the election of President.
(6) Address of retiring President, Dr. B. T. Dickson.

F. T. Bowman,
Hon. General Secretary.

NINTH GENERAL MEETING.

The ninth general meeting of the Institute was held in Adelaide on the 19th-20th August immediately before the meeting of the Australian and New Zealand Association for the Advancement of Science. It was held at the Waite Institute and was attended by from 30 to 45 members, including representatives from all branches. In the absence of the President (Dr. B. T. Dickson), who was on his way to the Food and Agriculture Conference in Copenhagen, Mr. H. G. Andrewartha, Chairman of the South Australian Branch, was invited to take the chair. Messrs. G. de V. Davis, G. W. Leeper and Dr. L. J. Teakle subsequently occupied the chair at different sessions. The meeting was the first to be conducted under a series of standing orders adopted by Council. Among other things these standing orders required the election of a number of committees for resolutions, time-keeping and scrutineering, and these were elected. While some of these committees had little, if any, work to do, others had some really formidable tangles to unravel.

The agenda for the meeting was limited to business matters affecting the Institute. Most of the items elicited considerable discussion and led to the adoption of the following resolutions.

(1) *Alteration of Articles of Association.*

Resolved that Article 10 in the Articles of Association be amended by adding the words " at the discretion of Council, honorary membership may be conferred for a period or for life " at the end of Article 10.

(2) *Awards of Merit.*

Resolved that this meeting recommends Council to give consideration to the creation of an award to be conferred periodically to encourage and reward the study of agricultural science.

(3) *Salaries and Status.*

Resolved that this meeting views with concern the inadequacy of salaries of research workers, especially those who are desirous of continuing for many years as investigational workers, and recommends that action be taken to provide higher status and salary for such workers.

Resolved that this meeting recommends Council to appoint a sub-committee for the purpose of making a new salary survey.

Resolved that on the basis of the data relating to status and salaries presented to this meeting and other immediately available data, a memorandum be prepared for use by Council and those Branches whose salary scales are below the Institute schedule.

Resolved that this meeting recognizes the importance of an adequate career range for members and recommends that every endeavour be made to have this range increased at least to the maximum of the discretionary range (£700) suggested in the Institute schedule.

(4) *Facilities for the Interchange of Personnel.*

Resolved that Council should prepare a report on the information obtained and any further information deemed necessary on the transfer of personnel from one service to another and make such report available for publication in the Journal or for distribution to members.

Resolved that Council should approach the Commonwealth authorities and that Branches approach the appropriate State authorities with a view to enabling transfers of personnel without loss of rights or privilege.

Resolved that Council should approach the Commonwealth authorities and Branches approach the respective State authorities with a view to encouraging and facilitating the interchange of personnel.

(5) *Proposed Journal of Agricultural Science.*

Resolved that this meeting expresses the desire that the Institute be associated with the C.S.I.R. in the proposed publication of a national journal of agricultural science and to submit a panel of names from whom referees on the editorial board may be appointed.

(6) *Sponsoring of Conferences.*

Resolved that Council invites suggestions from Branches, which, if implemented, would permit the Institute to play an important part in the organization of conferences of scientific workers.

(7) *Implementation of Institute Policy.*

Resolved that this meeting is of the opinion that Council should seek Branch opinion regarding the formulation of Institute policy and of the optimum means of implementing it with a view to the inclusion of this subject in the agenda of the next general meeting.

Resolved that this meeting recommends Council to give consideration to building up the financial position of the Institute.

Resolved that this meeting requests Council to recommend to Branches that they consider taking action to promote the coordination of (*a*) the work among extension services, and (*b*) the work among research services, throughout the Commonwealth.

MEETINGS OF COUNCIL

Meetings of Council were held at Science House, Gloucester Street, Sydney, on 6th August and on 1st October. At the former meeting most of the business was concerned with the agenda for the ninth general meeting.

Advice was received from the Department of Labour and National Service to the effect that it was creating a Higher Appointments Board with an office in each State and that the Institute had been invited to nominate a senior member of each Branch to act as a consultant to the local branches of the Appointments Board. Branches of the Institute were asked to forward their nominations to the General Secretary. The report of the Business Manager regarding Vol. XI of the Journal was received together with an audited statement of receipts and expenditure. This report appears on page 156.

At its meeting in October the principal business before Council was that arising from resolutions carried at the ninth general meeting in Adelaide. The manner in which these were dealt with is revealed below in notes from the council room written by one who was there. We hope to be able to maintain this practice of reporting Council affairs.

Membership.—The following applicants have been admitted to membership :—(*a*) as corporate members : E. F. Biddiscombe, W. T. Doig, J. H. E. Mackay (A.C.T.), F. C. Butler, K. E. Hutton, K. J. Symes (N.S.W.), T. McKnight, C. H. P. Defries (Q.), R. M. Baker, R. G. Beck, F. R. Humphries, B. S. Janes, A. R. Ninnes, M. B. Spurling, C. H. Williams (S.A.), C. A. Holland, N. A. M. Kjar, R. W. Wilson (Tas.) ; (*b*) as student members : S. E. Flint, G. K. Graham, J. G. Young (N.S.W.), K. B. Leske, R. T. Webber (S.A.).

Notes from the Council Room.

Faced with the task of implementing the decisions taken at the Adelaide meeting and recalling its protracted labours following the 1945 meeting in Melbourne, Council, at its meeting on 1st October, decided to decentralize the work by creating sub-committees located, as far as possible, within the Branches, which originated the respective topics concerned.

The various questions bearing on salary and status obviously called for the greatest amount of work and, for a time, it was thought to recreate the famous Victorian team of Vasey and Forster. However, deeming that they merited a respite in recognition of their splendid pioneering work in the past, the question was referred to a team from N.S.W., which Branch was also asked to further the problems of coordination in the fields of research and extension work.

" Awards of Merit " and the matter of " interchange of personnel " were referred to members of the A.C.T. Branch.

Other matters, referred to Branches generally for clarification, included the sponsoring of conferences and the important question raised by Tasmania, of a School of Horticulture. Queensland, referring to the Tasmanian claim that no facilities exist at present, pointed out that Lawes had been training diplomates in horticulture for some years past. However, the matter is deemed worthy of serious consideration and, whilst the Branches have been asked to expedite their reports, Tasmania has been asked to be rather more specific in its proposals.

On one matter, Council endeavoured to step neatly out of a labyrinth. Those who were present at the Adelaide meeting will recall the somewhat inconclusive nature of the debate on the question of " Institute Finance ". Council, declining to take the responsibility either for increasing subscriptions or decreasing rebates, resolved to point out to Branches that, if they

enrolled more members, they would have more revenue. In the debate on this resolution, the view was expressed that the Institute, partly through its own activities, partly through the lustre that it borrows from distinctions earned by its members, is now a feature in the agricultural scene of the Commonwealth. To ensure that it can act with even more strength and certainty, it needs only the knowledge that it does, in fact, speak for every member of the profession. Branches were asked to cooperate to this end .

One further question that was not completely solved at the general meeting was the " Implementation of Institute Policy ". Every member knows that, considerable as have been the achievements of the Institute in the few years of its existence, there lies within the scope of its charter potentialities for greater service both to the Commonwealth and to members. Only the widest possible canvass of Branch opinion can produce the best thought on this problem and, as a preliminary, Council has appointed a sub-committee to prepare a statement for submission to Branches with a view to the eventual formulation of a vigorous forward-looking policy.

G. DE V.D.

Report of Business Manager of the Journal for Vol. XI (1945).

Responsibility for the Journal was transferred to Adelaide in July, 1945, after the publication of Vol. XI, Parts 1 and 2. Parts 3 and 4 have been published under the direction of the new Publications Committee. The present Business Manager assumed responsibility for the Journal in September, 1945. It is desired to place on record his appreciation of the assistance rendered by the retiring Business Manager (Mr. N. C. Lloyd) in effecting the transfer and supplying valuable information on the management of the Journal, based on his experience.

As noted in an interim report presented in February, 1946, publication of Parts 3 and 4 of the Journal was unduly delayed as the result of industrial disputes in New South Wales. Besides delaying publication, these disputes added to the difficulties associated with the transfer of the Journal books and accounts to Adelaide. Numerous delays occurred in the checking and correction of the mailing list and the accounts for the volume could not be closed until 11th June, on receipt of the printer's account for Part 4 of the volume. This date is much later than usual (February or March). Subscriptions to Volume XII have, however, been kept separate, so that the cost to the Institute of Vol. XI can be clearly seen, from the accompanying audited statement of receipts and expenditure.

The position may be summarized as follows :

	£ s. d.	£ s. d.
Total expenditure on Vol. XI		352 2 4
Less Special Expenditure, Reprinting 100 copies of Part 1, ordered by Council	36 7 2	
Repurchase back Volumes	2 1 0	
	38 8 2	
Actual Expenditure on Vol. XI		313 14 2
Revenue for Vol. XI—		
Sale of Reprints	31 1 4	
Sale of Back Volumes and Numbers	11 13 8	
Subscriptions to Vol. XI	42 9 3	
Miscellaneous	3 1 0	
	£88 5 3	
Leaving the net cost for publication of Vol. XI at		£225 8 11

Detailed cost of printing Vol. XI, in comparison with the two previous volumes may be summarized as follows :

	Vol. XI.	Vol. X.	Vol. IX.
	£ s. d.	£ s. d.	£ s. d.
Printing	189 16 0	178 0 0	182 4 6
Blocks	15 12 7	7 18 0	17 10 0
Tabular matter	14 10 0	4 10 0	4 10 0
Additional 8-point type	5 17 0	7 3 0	0 13 0
Index	4 4 0	4 4 0	4 4 0
Total	£229 19 7	£201 15 0	£209 1 7

The total number of pages in Volume XI was 204. The basic paper ration for the Journal was increased by 20 per cent. during the year. Paper rationing has now been lifted and the future size of the Journal will be determined by the material coming forward for publication and the finance available.

Revenue from subscriptions to Vol. XI amounted to £42 9*s*. 3*d*. With £5 17*s*. 3*d*. paid in advance in the previous period, this amounted to £48 6*s*. 6*d*. and represented 89 subscriptions. One subscription remained unpaid at the end of the period. The number of subscribers to Vol. XI showed an increase of 11 over the previous volume. Present indications are that there

will be a further increase for the coming volume. Reprints of 25 papers totalling 3,450 separates were supplied to authors. As in previous years, these were supplied at cost price.

It should be noted that the charge for reprints from Vol. XI, Part 4, has not been included in the above accounts. As this charge will be recovered in due course by the Institute from those authors ordering reprints, it was thought desirable to close the books at this stage and so avoid the delay of waiting for these accounts to come to hand.

At the beginning of the period £7 14*s.* 2*d.* was owing for reprints. At the close of the accounting period £5 10*s.* 6*d.* was outstanding. This difference of £2 3*s.* 8*d.* must be added to the cost of publication of Vol. XI to give the adjusted net cost to the Institute of £227 12*s.* 7*d.*

The item reprinting of 100 copies of Vol. XI, Part 1, calls for comment. This was done at the direction of Council to meet the requirements of the Institute for this number, only 700 copies of which had been printed.—Eight hundred copies of each of the remaining parts were printed.

Vol. XI has been produced just within the amount of £230 budgeted by Council. Costs of production have been enhanced by charges associated with the transfer of the office of management, the preparation of a new mailing list and two lots of audit fees. Most of these items will be considerably reduced—now that the transfer is effected. It will, however, be necessary to print an additional 100 copies of Vol. XII, at an annual estimated cost of £7, to meet the additional demand and to avoid the uneconomic procedure of reprinting a part in short supply. The estimated cost of publication of Vol. XII based on information at present available is £240.

C. S. Piper.

MEETINGS OF BRANCHES.

New South Wales Branch.

At a meeting of the N.S.W. Branch on 12th July, Mr. H. J. Geddes gave an address on the " Changing Order in Dairy Cow Feeding ". He described his talk as an attempt to piece together a connected philosophy of economic nutrition as applied to the dairy cow. A condensed account of this talk is given under Current Notes on page 159.

At its meeting on 9th August, Mr. V. R. Webb, Technical Director of Thomas Robinson and Son Pty. Ltd., Flour Milling Engineers, gave a talk on South America from the point of view of the specialist in the handling and milling of grains. Reference is also made to this talk in Current News on page 160.

Queensland Branch.

Contributors to the September Notes and Exhibits meeting of the Queensland Branch were Dr. H. E. Young (" Wallum Soils ") and Messrs. W. J. Cartmill (" Lockyer Valley Soil Problems "), L. F. Mandelson (" *Rhizoctonia* on the Strawberry ") and P. J. Skerman (exhibits from the Cooper Flood Plain).

Mr. Cartmill stated that the soils of the Lockyer Valley are fertile alluvials of the black earth type initially possessing good structure and texture. Under irrigation there has been some degradation of structure, and fertility has also suffered. With underground waters containing 100 grains of mineral salts per gallon it is obvious that deleterious effects must follow applications of this water at rates as high as 40 inches in a year, but even with waters which would not be suspected, harmful effects have been noticed after a number of years. On heavy clay soils particularly, if the water contains calcium and magnesium bicarbonates high in proportion to sodium bicarbonate and the former is precipitated in the soil, dispersion of the colloids in the surface layers may occur, causing serious waterlogging. Another problem concerns the use of fertilizers in the Laidley Creek Valley, where responses were obtained from superphosphate on soils containing over 1,000 p.p.m. (Truog) of P_2O_5. Experimental work has indicated that gypsum is as effective as superphosphate. Its effects may be threefold, viz. correction of physical condition of the soil brought about by sodium bicarbonate in the irrigation water, release of potash by the breaking down of insoluble minerals, and direct effect of sulphur on plant growth. Additional trials with potatoes have indicated a response to potash.

Mr. Mandelson reported on the occurrence of the fungus *Rhizoctonia* sp. on the roots and crown of strawberries, a new record for Queensland. An interesting feature is that bracken fern, which is known to carry *Rhizoctonia* in America, occurred previously on the affected patch.

Mr. Skerman described the channel country of western Queensland and exhibited specimens of the most important plants together with a series of photographs.

South Australian Branch.

A general meeting was held on 23rd August during the Adelaide meeting of the A.N.Z.A.A.S. After a buffet tea at which interstate visitors were welcomed, an address was given by Dr. O. H. Frankel, Chief Executive Officer of the Wheat Research Institute, Christchurch, New Zealand, who spoke on " International Cooperation in Plant Research ".

Dr. Frankel pointed out that as the basis of plant research is the utilization of plant material, we must realize what plant resources mean. In addition to our immediate cultivated plants,

there exist twelve natural centres of plant varieties in the world and we should use these to obtain plant material.

It would thus be possible by pooling cultivated species and by excursions to natural centres to set up plant collections on a world-wide basis instead of the small restricted collections now existing.

Work could then be carried out on these collections to maintain them properly and also to do progressive research with them. This progressive work would include taxonomic studies—cytology and genetics, disease resistance, yield, etc. Material possessing specific genes or genetic characters could then be drawn on by workers all over the world.

The localities selected for maintenance of these collections should be suitable for the whole range of closely related plants.

Dr. Frankel believes that obstacles to be overcome in starting such plant collections are not insurmountable. New Zealand already has a considerable wheat collection.

In addition to these plant collections, Dr. Frankel pointed out that there was too little cooperation between plant breeders in the way of material. Each worker has a large number of hybrids and only very few are of use to him. The remainder instead of being thrown out, should be made available to other workers in different environments to whom they may be of value.

In young countries such as Australia and New Zealand, it is important that we cooperate more with each other and the rest of the world.

On 15th November a general meeting was addressed by Messrs. D. S. Riceman and H. J. Lee, of the Division of Biochemistry and General Nutrition, C.S.I.R., on minor element work.

Mr. Riceman gave an interesting account of the minor element work, in relation to plants, which has been carried out at Robe.

The early experimental work was largely exploratory to determine what elements, major and minor, were lacking. Trials with N, P and K fertilizers yielded inconclusive results. The use of copper and zinc used at high and low levels, combined with a detailed analysis of tillering, elongation, grain yield, etc., of the plants, gave more definite results.

The interactions due to the addition of these different elements have been further complicated by an effect which appears to be due to the influence of copper, etc., on the activity of soil organisms. If some of the fertilizers, including copper and nitrogen, are applied several months before sowing, their effect, particularly on grain yield, is much more marked. The copper may stimulate the activities of the soil organisms so they can act on the nitrogenous and other fertilizers and render them available to the plant.

Mr. Lee discussed the problem of minor elements in relation to animals in the Robe area.

He referred to the historical background of " coast " disease in sheep with the German work on toxicity of excess cobalt and its interpretation by Thomas and others.

It is now definitely established that " coast " disease is due to cobalt and copper deficiency with cobalt as prime limiting factor.

" Steely " wool and an ataxia known as " rickets " appear to be due mainly to copper deficiency and Mr. Lee showed several interesting photographs of sheep affected by the deficiencies.

A feature of the deficiencies particularly copper has been their irregular occurrence from one year to another in the same area. Work is now being carried out in conjunction with the wool companies to trace all areas in the State where " steely " wool occurs and to prepare maps. This will be followed up by soil investigations.

Tasmanian Branch.

The first complete meeting of the Branch held in the north since early in the war took place at a dinner at "The Village Inn", St. Leonards, on Tuesday evening 8th October. A full attendance of northern members and a representative number of southern members were present.

The President, Mr. F. E. Ward, in his opening remarks, took the opportunity of welcoming three new members, Messrs. N. Kjar, R. W. Wilson and C. A. Holland.

The main discussions of the meeting centred around the recent Council meeting in Adelaide, and the Branch representatives present, Messrs. L. Miller and E. F. Fricke, gave a brief report of the proceedings. Particular interest was taken in the introduction of agricultural subjects in universities and technical schools, awards of merit within the Institute and the attendance of Branch delegates at Council meetings.

Victorian Branch.

On 13th September members attended a meeting held by the Melbourne University Agricultural Society, when Dr. I. F. Phipps, now on the staff of Imperial Chemical Industries of Australia and New Zealand, gave a survey of present-day agriculture and agricultural research in New Zealand. Dr. Phipps said that as the land area and population of New Zealand were approximately equal to those of the State of Victoria a comparison of the primary industries of the two areas was appropriate. The major difference was that New Zealand's primary production was based predominantly on sown pasture which maintained practically all of the 33 million sheep and 4½ million cattle in the country. Much of the 14 million acres classified as native pasture was rough grazing highlands of low carrying capacity.

The features that had contributed towards New Zealand's development into a productive and efficient primary producing country and the greatest producer per head of population were as follows :

1. A favourable climate for the growth of pasture, i.e. an adequate, well-distributed and reliable rainfall with moderate temperatures.
2. Soon after the development of refrigerated shipping space in 1882 New Zealand rapidly developed her export of dairy and meat products to Great Britain.
3. The effective use of comparatively poor soils which are highly deficient in phosphate, generally acid, and with local deficiencies of potash, cobalt, copper, barium and magnesium. Adequate use of fertilizers is an important story in the establishment and maintenance of pastures in New Zealand.
4. The Departments of Agriculture, of Scientific and Industrial Research and the Cawthron Institute which are well organized for research, education and advisory work in agriculture and the animal production fields. Australia has much to learn from the N.Z. Department of Agriculture in its agricultural extension work amongst farmers.
5. The outstanding success attained in the selection and breeding of improved types of pasture plants adapted to the various climatic zones of the country.
6. The development of effective methods of pasture management.
7. Cheap hydro-electric power and almost complete mechanization of farming, from milking machines on practically every farm to header-harvesters for harvesting pasture seeds.
8. Good roads and effective road transport.
9. Low costs of production for primary produce exported to the United Kingdom.

Assuming the free movement of goods in future without embargoes, subsidies or dumping of surplus products there was little doubt that New Zealand could compete with any other country, both on costs of production and quality of products from her farm lands.

Mr. A. J. McIntyre addressed the M.U.A.S. on 1st November, when Institute members also attended. His subject was " Social Problems in Agriculture ". Mr. McIntyre made a comparison in the standards of living between farms in the wheat belt and the more closely settled dried fruit blocks near Mildura and suggested reasons for the differences. The lecturer concluded by stating that more people were not needed on the land, a better education in rural areas was a necessity, small farms should be discouraged, there should be more highly trained people available to make best use of new farming techniques, a proper wage system should be instituted and farming should be approached as a way of life.

Current Notes and News

Coordination of Cereal Breeding and Genetics.

An opportunity for Australian and New Zealand workers in cereal breeding and genetics to meet and discuss their mutual problems was provided in a conference held at Roseworthy Agricultural College, South Australia, on 15th and 16th August last. The conference was arranged by the Australian Agricultural Council on the recommendation of the Australian Institute of Agricultural Science and was attended by delegates from the C.S.I.R., Department of Commerce and Agriculture, the State Departments of Agriculture and the Universities of Sydney and Adelaide. Two men from New Zealand were present. Dr. A. R. Callaghan, Principal of the Roseworthy Agricultural College, provided hospitality for the delegates and acted as chairman throughout the conference.

The following delegates were present : Dr. O. H. Frankel, Mr. I. L. Elliot (N.Z.), Mr. K. Loftus Hills (Commonwealth), Drs. S. L. Macindoe and I. A. Watson and Mr. W. T. Atkinson (N.S.W.), Messrs. A. R. Raw, H. J. Sims and P. Debrett (Vic.), Dr. L. W. Samuel and Mr. A. J. Millington (W.A.), Dr. L. G. Miles (Q.), Dr. A. R. Callaghan and Messrs. L. J. Cook, E. J. Breakwell, J. V. Mertin, A. T. Pugsley and A. J. Farquhar (S.A.) and Mr. E. F. Fricke (Tas.).

A report of the proceedings of the conference has been prepared for submission to the Australian Agricultural Council.

Changing Order in Dairy Cow Feeding.

In his talk to the N.S.W. Branch, Mr. H. J. Geddes pointed out that the standard text books give surprisingly little prominence to the economic aspects of feeding. None has yet caught up with a highly important recent development that alters the whole picture of economic feeding.

Recent research into the importance of protein quality in dairy cow rations by Cornell University has provided fresh support for the policy of choosing feeds in accordance with relative cost per unit of energy or protein. Protein quality is relatively unimportant in cow rations.

Further work on the single factor system of comparing stock feeds has resulted in the development of a circular slide rule which has been calibrated to suit the requirements of sheep-feeders and issued by the Australian Wool Board to all who attend the screenings of the drought-feeding film. This calculator is equally adaptable to the choosing of feeds for dairy cows.

Experience in the rationing of farmers' herds has emphasized the importance of correct balance in dairy rations. In one herd the balancing of the ration led to an increase of 25 per cent. in the milk production within a fortnight despite the fact that the herd did not receive a single pound more of feed.

The most important development in economic feeding has been the work of Jensen, Klein, Rauchenstein, Woodward and Smith (Technical Bulletin 815, U.S.D.A. : Input-Output Relationships in Milk Production). Their work establishes the fact that the feeding of cows obeys the Law of Diminishing Returns.

Individual feeding in accordance with yield has distinct economic possibilities. In Burnside Homes dairy the change-over from flat rate to individual feeding led to an immediate effect in a saving of 25 per cent. in the quantity of concentrates consumed without any diminution of yield.

Outside the whole milk areas, Australian dairying is mainly based upon pasture. The system of predicting the most profitable level of hand-feeding cannot be applied without modification to pasture-based dairying because the feeder is unable to make an accurate estimation of the intake of nutriment from the pasture. The use of the current yield of milk as a measure of food intake is not satisfactory without a knowledge of the productive capacity of the cattle under good conditions, their stage of lactation and their persistency.

Work at Massey Agricultural College (N.Z.) indicates that yields cannot be increased by feeding concentrates to cows grazing first-class pastures of rye grass and clover when these pastures are in active growth. Evidence from Australian sources, however, and what is known of the inherent productive capacity of dairy cattle suggest that concentrate feeding may have considerable potentialities here.

The average yield of butter fat per cow in Australia is between 150 lb. and 160 lb. The potential yield of the cow population is nearly 300 lb. The low yields of butterfat per acre, even on what are regarded as our main dairying areas, provide additional evidence of the opportunities for improving output by supplementary feeding.

The question arises as to whether concentrates should be fed in conjunction with pastures in Australia. Before that practice is considered, however, pasture improvement should be undertaken.

The use of other home-grown feeds should also have precedence over concentrates ; but low protein roughages may depress rather than improve milk yield. Pasture should contain not less than 13 per cent. crude protein on a dry matter basis to give a satisfactory milk yield. Clowes' analyses of paspalum pastures at Kameruka showed that the herbage even in what is usually regarded as the most nutritious stage contained less than 13 per cent. crude protein in its dry matter.

The potentialities of supplementary feeding with concentrates are indicated by the work of Ferguson at Kameruka Estate, Bega. Profitable responses to limited concentrate feeding—at rates far below the quantities usually given in full hand-feeding—were recorded. In a later trial conducted by the Estate itself, an increase in milk yield valued at £3 10*s*. per cow was obtained from an outlay for feed of £1.

South American Agriculture.

Speaking at a meeting of the N.S.W. Branch, Mr. V. R. Webb said that the continent of South America is much greater, both in area and in population, than is generally appreciated in Australia. In has an area of 7·7 million square miles, or about 2½ times the area of Australia. The surprising thing, however, is the population, because although vast areas of the continent are uninhabitable jungle and mountain regions, the population is over 85 millions, or about 12½ times the population of Australia.

Mr. Webb then spoke about each of the several South American republics. Argentina was probably the richest and most powerful South American republic at the present time. Its area is approximately one-third that of Australia with a population of 11½ million people. This population is much more evenly spread than in Australia for only 27 per cent. of the population live in towns of 20,000 or over, as compared with Australia's 45 per cent. Buenos Aires has 2·3 million inhabitants and is extremely modern in every respect.

The Argentine is a flat, alluvial plain, rising at its western frontier with Chile to the top of the Andes Mountains.

Originally these plains were virtually treeless and with coarse native grasses, but subterranean clover and alfalfa have been extensively cultivated with most surprising results.

In the northern area of the plain country the climate is hot and dry, and in the south one passes out of the agricultural belt into the Rio Negro, which is the centre of the fruit-growing industry, and thence south to Patagonia, where there are still Welsh speaking colonies and considerable cross-bred sheep production.

There is virtually no stone in the plain country ; paving stones are imported from the neighbouring Republic of Uruguay.

Farming in Argentina is highly mechanized and has been so for many years. Because of its flatness the agricultural belt lends itself ideally to mechanization. It is no uncommon sight to see a farmer directing his tractor or disc plough for several miles in a straight line towards a large flag which he has placed to guide him in making his first furrow.

Argentina is fortunate in having few droughts and a fairly regular rainfall of about 35 inches per annum through its agricultural zone.

Referring to grain handling and classification, Mr. Webb said that in 1927 English millers used approximately 20 per cent. of Argentine wheats in their mixtures solely on the score of price. The grain was recognized as having no outstanding characteristics, being somewhat dirty and irregular in quality. At this time Australian wheat was customarily used up to about 25 per cent. of the British millers' grist on the score of good bloom, colour and flavour.

In the intervening years up to the present time, however, the position has unfortunately changed very greatly.

The government of the Argentine has spent many millions on an elaborate system of grain elevators, extending from small country silos right through to the port terminals. Wheat is hardly ever handled in sacks, even on the farms.

The government and many private firms have specialized in the control of varieties to suit the climate and soil belts by the somewhat coercive method of refusing to handle unauthorized varieties through the government silos and adopting classification system similar to that of Canada.

Altogether, then, the Argentinian farmer has been completely dissuaded from growing poor varieties of wheat even if they give good bushellage per acre.

Argentine wheat is now sold exactly as is Canadian. As a result it is now accepted in the British market with a clear knowledge of its characteristics long before the harvest is gathered, and price is not now the reason why Argentina is selling more wheat to England than we are. The following figures will show the trend :

	1935	1939
	£	£
Australian wheat sales to England	5·3 million	3·5 million (18%)
Argentine wheat sales to England	6·0 million	6·2 million (23·8%)

It should not be concluded that England is the Argentine's only or even its chief market ; the large population of Brazil is largely fed with Argentine wheat and big consignments are sold to overseas countries.

Vacancies on Staff of Imperial Agricultural Bureaux.

The executive of the I.A.B. is seeking applications for two posts as Directors of Bureaux and four posts as Assistant Directors. The Bureaux for which Directors are sought are those of Animal Breeding and Genetics and Forestry. The former is located at and works closely with the Institute of Genetics in the University of Edinburgh, while the latter is associated with the Imperial Forestry Institute at Oxford. The salary grade is £840-30-1,200-50-£1,300. The four Bureaux for which Assistant Directors are sought are those of Soil Science, of Dairy Science, of Horticulture and Plantation Crops, and of Pastures and Forage Crops (including Field Crops).

The salary grade for each of these positions is £600-25-£800 (bar)-25-£900. Applications for any of these posts should reach the Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1, by March 1st, 1947.

The work of collecting, collating and making available to scientific research workers which these Bureaux do is well known to members. Any further information on qualifications required and the conditions of appointment may be obtained from the Council of Scientific and Industrial Research, 314 Albert Street, East Melbourne, C.2.

Book Reviews

FOREST SOILS AND FOREST GROWTH, by S. A. Wilde.

(Waltham, Mass., U.S.A., Chronica Botanica Co. ; Melbourne, N. H. Seward, 1946. *Price,* $5.)

This book in its preface and early chapters comprises a philosophical and scientific discussion of forest soils and their significance in forest growth. The later chapters consist of a technical manual of sylvicultural practice dealing particularly with those operations in which consideration of the soil is necessary. Some of the statements made by the author such as " an understanding of the forest lies just as much below as above the ground line " will be more or less readily accepted but only the Australian forester with a pedological training is likely to agree that consideration of the soil is of the greatest importance in the cutting system adopted.

In dealing with the genesis of soils and the great soil groups some statements will not find ready acceptance by soil scientists. In this connexion the deliberate misuse of the word kaolinization to cover all types of clay forming processes is regrettable and the statement that laterization is confined to hot humid tropical and sub-tropical regions ignores the details of the genetic process involved in its formation and its geographical distribution. Types of soils associated with laterite are on the other hand adequately described. Another statement that "*terra rossa* is a soil derived from calcareous substrate in regions of lateritic weathering" does not accord with its actual geographical occurrence.

Pedologically the most valuable part of the book is the chapter on hydromorphic soils. Wilde is a recognized authority on gley soils and his description of the influence of different degrees of gleization on the soil profile is comprehensive.

In dealing with soil as a function of environmental factors and time, the formulation $S=\int(g.e.b.)dt$ (in which S is the soil, g is the geological substratum, e is environmental influences, b is biological activity, and t is time) will, as an integration of the soil forming factors against time, appeal to many rather more than the formulæ of Dokuchaev and Jenny. On the other hand his rearrangement of the great soil groups into classes bearing new names such as grood, charral and melanized soils appears quite unwarranted.

A statement in Chapter III ; "If properly delineated, genetical soil types provide a reliable framework for the acclimatization or translocation of tree species . . ." ignores the fact that genetical soil types do not necessarily occupy identical climatic zones (homoclimes) in the different countries of their occurrences.

The book is notable for the dearth of material from the southern hemisphere. Its value to Australian foresters will be, not so much in the information it contains, but the stimulus it provides to seek corresponding data about Australian forest soils.

C. G. Stephens.

THE CLIMATOLOGICAL BASIS OF FORESTRY, NEW SOUTH WALES. PART I, by W. A. W. de Beuzeville.

(*Being a summary of evidence given before the Rural Reconstruction Commission, September*, 1943. 62 *pp., one map.*)

Those who have followed the reports of the Rural Reconstruction Commission and have noted the issue of the regional maps of New South Wales published by the Division of Reconstruction and Development of the Premier's Department, will have been aware of the existence of a system of climatic classification sponsored by the Forestry Commission of that State. The publication under review presents the system in some detail and is consequently to be welcomed by students of climatology. The paper is made up of a series of somewhat disconnected arguments and data and deals briefly with (i) Climate, (ii) The Climatological Basis of Forestry, and at some length with (iii) Distribution of Forest Types and Species. Then follows a brief discussion on (iv) Application of Homoclimes. These four discussions complete the first 23 pages. Then follow 39 pages of schedules of data covering stations from all parts of Australia, together with data for corresponding stations in other parts of the world. These schedules are stated to be from the Climatic Index 1938, presumably that of E. H. F. Swain published by the Forestry Commission of New South Wales.

The bases of climatic comparison are (*a*) mean temperature of the coldest month, (*b*) mean temperature of the hottest month, (*c*) the number of months with a mean temperature greater than 48° F., (*d*) the number of months with rainfall below 2·0 inches and 1·5 inches, (*e*) the lowest monthly rainfall and the season in which it falls, and (*f*) the mean annual rainfall.

On the basis of these $8\times9\times3=216$ climatic zones are defined and designated in terms of two numerals and one letter—thus, zone 8·6 *c* includes much of the Riverina and is compared with parts of California, Greece, Turkey, Spain and Sardinia. The comparisons are mostly quite apt and must have involved a considerable amount of search through the data. The temperature parallels can be equally well attained by using annual mean and either range or amplitude. The reviewer has shown that phase expressed as lag behind solar radiation which determines spring and autumn temperatures, can be used in addition.

The basis for the determination of length of season, the number of months receiving less than two inches of rain, is rather outmoded, and any future revision of the system could well make use of one of the moisture indices that have been used so extensively by Australian climatologists, since the reviewer introduced the Meyer ratio to Australian workers in 1931. The next most extensive section is that dealing with the distribution of forest types and species. The grouping is based essentially on the mean temperature of the coldest month, and on the mean annual rainfall. In the tables there is some obscurity with respect to the use of the word "range" to indicate either the range of temperature of the coldest month or the range between the coldest month and hottest month.

In the section on the application of homoclimes, the usefulness of the tables is suggested with respect to forestry, agriculture, architecture and fur farming. In the latter case tables are given intended to show the essential similarities between certain alpine climates in Australia and

selected climates in Norway, Canada and Alaska. Some of these parallels are quite striking, as for example,

	Altitude. Feet.	Mean Temperatures.		Lowest Monthly Rainfall. Inches.	Season.	Mean Annual Rainfall. Inches.
		Coldest Month. ° F.	Hottest Month. ° F.			
Kosciusko, New South Wales	5,018	32	55	2·7	Summer	49
Christiansund, Norway	79	34	56	2·1	Summer	46

This is followed by some suggestions for plant introductions.

On the whole the publication suffers most from the rather loose coordination of its component parts : its greatest merit lies in its two sets of data with respect respectively to climatic parallels and the requirements of eastern Australian tree species. These tables will prove useful to other workers in this field. A list of sources of information of the climatic data would have added to the usefulness of the publication to the climatologist.

Part II, which is promised, is to include climatological maps of Australia and New South Wales.

J. A. PRESCOTT.

TRACE ELEMENTS IN PLANTS AND ANIMALS, by Walter Stiles.

(Cambridge University Press. 1946. 189 pp. Price, 12/6 stg.)

Although it is some 30 years since the experiments of Mazé focussed attention on the essentiality of trace elements for normal plant growth, it is only within the last 10 to 15 years that most of the not inconsiderable knowledge on this subject has been obtained. As there now exists in scientific journals a very large number of papers dealing with many aspects of the subject of trace elements, particularly in plants, there is need for a comprehensive assessment of the progress made to date. Such a review would greatly assist in determining the lines along which future research may be profitably directed. It is these very useful functions which Professor Stiles' book is intended to fulfil.

After giving a historical introduction to the subject the author discusses methods of investigating micronutrient problems, such as purification of materials, estimation of trace elements in plant material, and diagnosis of deficiencies in plants. Descriptions are given of plant diseases attributable to deficiencies of manganese, zinc, boron, copper and molybdenum respectively, followed by a chapter on the functions of the first four of these elements in plants. A chapter is also devoted to trace elements in animals, including diseases due either to trace element excess or deficiency, with a short note on their functions in animals. The final chapter gives a short discussion of possible lines for future research, while a comprehensive index is included.

There are 432 literature citations, but owing to an apparent desire to restrict the size of the volume, these unfortunately do not cover all available aspects of the subject of the book, while some important references to aspects discussed have been omitted. For example, in reviewing work on mottle leaf of citrus no reference is made to the contribution of Chapman and co-workers, who in 1937 first reproduced this condition in zinc-deficient cultures.

However, in spite of such limitations, Professor Stiles has made a very useful contribution, which will be welcomed by all interested in trace elements in plants and animals.

C. R. MILLIKAN.

COPPER AS AN INDISPENSABLE ELEMENT FOR PLANTS AND ANIMALS, by W. J. Melchers and H. J. Gerritsen.

(Published by the authors, Velp bij Arnhem. Holland, 1944. 56 pp. Price, 1.90 Dutch florins.)

This book gives a brief account of the occurrence of copper deficiency in Holland. It is written in Dutch and contains five page summaries in English, French, and German. An introductory chapter lists a number of plant and animal diseases occurring in different parts of the world and attributed to copper deficiency. In this list all reference to copper deficiency diseases of animals in Australia is omitted, while the only New Zealand reference is to " Bush sickness ", a disease which is due to a deficiency of cobalt and not copper. Other diseases wrongly included in this list because they also are primarily due to a deficiency of cobalt are " Nakuruitis " (Kenya) and " Pining " (Scotland).

In the section dealing with the growth of various crops on the copper-deficient soils of Holland it is indicated that canary seed and wheat are among the plants most susceptible to copper deficiency. Typical symptoms on these and many other crops are described and illustrated by several plates. Among plants thriving on soils deficient in readily available copper, carrots, buckwheat and spurry are mentioned.

In controlling reclamation disease in Holland, copper sulphate is used at rates varying from 50 to 100 kilograms per hectare. The effectiveness of copper sulphate is reduced by lime but it may be mixed with other fertilizers without loss. It is stated that, in recent years, good results have followed the use of a finely ground slag from a copper smelting works. This slag contains 1 per cent. of copper and is used at rates supplying 4-5 kilograms of copper per hectare. This is less than half the equivalent amount of copper supplied in the usual applications of copper sulphate.

In another chapter brief mention is made of the animal diseases associated with the various copper-deficient soils of Holland.

The book is written essentially from a national standpoint. Thus, although the recognition of the curative effect of copper on reclamation disease is rightly attributed to Hudig, " the convincing proof that the disease is caused by a lack of copper " cannot be attributed to Mulder, as is done on page 49, in view of the earlier work of many other investigators elsewhere, notably Brandenberg, Rademacher and Arnd and Hoffmann. The book also suffers from a complete lack of literature references, which are to be expected in a work of this type.

C. S. PIPER.

Personal Notes

Dr. J. R. A. McMillan has been appointed to the Chair of Agriculture at the University of Sydney in succession to Professor R. D. Watt, who will retire at the end of this year.

Dr. C. J. Magee, Chief Biologist, New South Wales Department of Agriculture, left Sydney by flying boat on 29th October. He went at the request of the British Colonial Office to investigate the diseases of manilla hemp in north Borneo. The industry had been established there by the Japanese during their occupation of the area. Manilla hemp is superior to other fibres because of its resistance to deterioration in salt water, and it is very desirable that the industry should be fostered.

R. J. Swaby, Bacteriologist, New South Wales Department of Agriculture, has been awarded a Ben Fuller Travelling Scholarship and sailed early in October for England, where he will work under Dr. H. G. Thornton at Rothamsted. He proposes to continue his work on soil microbiology, and hopes to study the relative merits of composting, stubble mulching, green manuring, rotational cropping and ley farming for restoring the humus and crumb structure of depleted soils. He was farewelled at a luncheon at which the founder of the trust, Sir Benjamin Fuller, and all former Ben Fuller Scholars, Drs. Noble, McMillan, Magee, Harrison and Bowman, were present ; the opportunity was taken to extend the appreciation of agricultural scientists to the founder for his benefaction.

Dr. B. T. Dickson has just returned from Copenhagen, where he attended the Food and Agriculture Conference of the United Nations Organization as one of Australia's representatives to the Conference.

C. M. Donald is in Western Australia, where he is inspecting properties in the north-west of the State to decide whether exploited areas should be taken over by C.S.I.R. and an attempt made to restore their fertility.

R. Norris is in Western Australia reopening the problem of red-legged earth mite. This work will be carried on by M. Wallace.

O. St. J. Kent has resigned from the Queensland Department of Agriculture and Stock to take up the dual position of Principal of the School of Dairy Technology and Chief Dairy Technologist at Werribee (Vic.).

F. W. Blackford has resigned from the Queensland Department of Agriculture and Stock to join a commercial firm in a technical capacity.

K. T. Lutz, Agricultural Adviser in the Western Australian Department of Agriculture, and formerly in the 2nd A.I.F., has been appointed Principal of the Rural Training Centre at Harvey, which has been established for the training of ex-service personnel and under the provisions of the Commonwealth Reconstruction Training Scheme.

Professor H. C. Trumble is returning on the " Wanganella " from Vancouver. He expects to be in Australia by 28th December.

R. N. McCulloch has been appointed Deputy Principal of Roseworthy Agricultural College.